A PROPOSAL FOR AN ENERGY-EFFICIENT SCHOOL BUILDING MODEL IN KIRKUK/IRAQ

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MSc Thesis

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MASTER THESIS

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TABLE OF CONTENTS

SUMMARY

A PROPOSAL FOR AN ENERGY-EFFICIENT SCHOOL BUILDING MODEL IN KIRKUK/IRAQ

Despite the global trend towards reducing and rationalizing energy consumption in all of its forms of lighting, heating and cooling, building constructions in Iraq related to energy consumption and resources still proceed without awareness or study. The conservation of energy in the built environment should become one of the most important topics in both political and scientific programs in Iraq as a global trend issue. The growing population of Iraq, the decreasing fossil-based energy resources and the increasing emissions of harmful gases has emerged as a collection of major catalysts for energy efficiency in buildings. In addition, cost efficiency, safety and the need to reduce carbon emissions are the key reasons for energy conservation. At the moment, there has been an incredible increase in the amount of energy used in Iraq and there is an increasing reliance on energy resources and energy consumption in the most efficient way in every sector, and in the building sector especially.

Construction buildings in Iraq ignore thermal design calculations, which has led to an uncomfortable indoor climate and the use of a lot of energy during the year. Achieving the energy efficiency of buildings particularly in Kirkuk city is critical due to the continuous energy crisis.

The aim of this study was to investigate the effect of the Passive and Active Design parameters in the building design to reduce energy consumption. For this purpose, a School Building Model (SBM) was determined in the Kirkuk/ Iraq region. The amount of energy savings resulting from the application of thermal insulation, building orientation, building forms and window area according to the wall or floor ratio in the buildings was examined. There re two programs (Revit and green building studio) used to simulate the thermal loads and the amount of energy needed for the determined school building sample for the year period. The (SBM) building will be useful at reducing the energy consumption to a more environmentally friendly and energy-efficient level. In addition, the pvSOL tool was employed to simulate the photovoltaic (PV) panels assumed to be installed on the top of the roof of the (SBM).

Keywords: Energy efficiency, Thermal Design, BIM, Solar Energy, Building-integrated Photovoltaics, PV*SOL.

ÖZET

KERKÜK/IRAK'TA ENERJİ ETKİN OKUL BİNASI MODELİ ÖNERİSİ

Tüm aydınlatma, ısıtma ve soğutma biçimlerinde enerji tüketimini azaltma ve mantıklı davranma yönündeki küresel eğilime rağmen, Irak'ta enerji tüketimi ve kaynakları ile ilgili inşaatlar hala farkındalık olmadan veya araştırmaya dayanmadan devam etmektedir. İnşa edilen ortamda enerjinin korunması, küresel bir trend sorunu olarak Irak'taki hem siyasi hem de bilimsel programların en önemli konularından biri haline gelmelidir. Irak'ın artan nüfusu, azalan fosil temelli enerji kaynakları ve artan zararlı gaz emisyonları, binalarda enerji verimliliği için önemli katalizörlerin toplamı olarak ortaya çıkmıştır. Buna ek olarak, maliyet verimliliği, güvenlik ve karbon emisyonlarını azaltma ihtiyacı, enerji tasarrufu için temel nedenlerdir. Şu anda, Irak'ta kullanılan enerji miktarında inanılmaz bir artış olmuştur ve her sektörde ve özellikle inşaat sektöründe en verimli şekilde enerji kaynaklarına ve enerji tüketimine artan bir bağımlılık vardır.

Irak'ta inşa edilen binalar, iç mekanlarda rahatsız edici bir havaya ve yıl boyunca çok fazla enerji kullanımına neden olan termal tasarım hesaplamalarını göz ardı etmektedir. Özellikle Kerkük şehrinde binaların enerji verimliliğinin sağlanması, süregelen enerji krizi nedeniyle kritik öneme sahiptir.

Bu çalışmanın amacı, bina tasarımında enerji tüketimini azaltmada, Pasif ve Aktif tasarım parametrelerinin etkisini araştırmaktır. Bu amaçla Kerkük/ Irak bölgesinde bir Okul Binası Modeli (OBM) belirlendi. Binalarda duvar veya zemin oranına göre ısı yalıtımı, bina oryantasyonu, bina formları ve pencere alanının uygulanmasından kaynaklanan enerji tasarrufu miktarı incelenmiştir. Termal yükleri ve belirlenen okul binası örneği için yıl boyunca ihtiyaç duyulan enerji miktarını simüle etmek için kullanılan iki program (Revit ve green building studio) kullanılmıştır. OBM binası, enerji tüketimini daha çevre dostu ve enerji tasarruflu bir seviyeye düşürmede faydalı olacaktır. Ek olarak OBM çatısının üstüne monte edildiği varsayılan fotovoltaik (FV) panelleri simüle etmek için PV*SOL yazılımı kullanılmıştır.

Anahtar Kelimeler: Enerji verimliliği, Termal tasarım, BIM, Güneş Enerjisi, Binaya entegre fotovoltaikler, PV*SOL.

LIST OF FIGURES

LIST OF TABLE

Page no.

LIST OF ABBREVIATIONS

SBM	: School Buildings Model
PV	: Photovoltaic
BIM	: Building Information Modeling
LEED	: Leadership in Energy and Environmental Design
HVACs	: Heating Ventilation and Air Conditioning System
CSO	: Central Statistical Organization
WWR	: Windows to the wall ratio
WFR	: Window to Floor Ratio
WG	: Window Geometry
NVS	: Natural Ventilation Systems
BIPV	: Building-Integrated Photovoltaics
SHGC	: Solar Heat Gain Coefficient
SC	: Shading Coefficient
R	: Thermal Resistance
K	: Thermal Conductivity
C	: Thermal Conductance
D	: Thickness of material
W	: Watt
ASHRAE	:American Society of Heating, Refrigerating and Air-Conditioning Engineers
ANSI	: American National Standards Institute
ISO	: International Organization for Standardization
DF	: Daylight factor
IES	: Illuminating Engineering Society
KWh	: Kilowatt/ hour
KWp	: Kilowatts peak
AC	: Alternating Current
DC	: Direct Current

1. INTRODUCTION

The building/construction sector is one of the major consumers of natural resources such as land and water, as well as manufactured materials. It also produces a large number of pollutants and solid waste as a result of the materials and energy used. To eliminate these negative effects, many countries have taken precautions in order to diminish the amount of pollution and energy consumption by enacting mandatory regulations.

Especially in architecture, new concepts and methods have emerged that are familiar in architectural thought such as building energy-efficient designs and green architecture, which shows the relationship between buildings and the environment. There are many definitions of sustainability and in the case of energy-efficiency in buildings, the term is often used interchangeably with energy efficiency or “eco-buildings” [1]. These concepts respect the environment and the right to a healthy and decent life of future generations. Reflecting the growing interest of the building sector in the protection of the environment, the optimal utilization of natural resources reduces the energy consumption and raises the belief in the usage of renewable energy sources. It is known that energy-efficient architecture has many successful and effective samples. Hover, it is evident that these examples are still ignored and this situation is leading to significant environmental problems in many parts of the world.

Experts emphasize that if today's society does not take the design of energy-efficient buildings seriously as a way of life, they may jeopardize the lives of the future generations. The development of energy efficiency is the product of society's efforts through long-term, holistic lines towards achieving and developing a balanced society based on ll-considered environmental, economic, social and political policies. The appropriate thermal design of the building envelope reduces the heat and cooling loads required for heating and air conditioning. This determines the use of low-cost, low-operational heating and cooling devices [2]. The objective is to reduce costs and energy consumption and to provide a comfortable environment within the building. There are several things to consider when designing the exterior sides of the building, both environmentally and thermally, such as the thermal insulation of the external structural elements, the correct selection of the external windows in the different types, areas and orientations and the closure of their joints in front of air leakage [3]. It also includes natural ventilation to provide thermal comfort and attention being paid to the integration of natural lighting systems when designing openings, which has a key role in reducing the energy consumption used in artificial lighting [4].

School buildings are a type of building that is of great interest when look at possible linkages between building performance and the benefits of a healthy, productive and comfortable environment. Children spend long periods of time in classrooms and a good internal environment can help to improve student performance. If the trend towards building eco-friendly school buildings continues, then there is likely to be an increased interest in the ways in which an energy efficiency design intersects with environmental education. The improvement of educational conditions is considered to be the cornerstone for advancing society towards comprehensive development as it is the first basis for raising future generations. The education sector is known as the locomotive of countries that aim to grow economically, socially and culturally [5]. School buildings have become one of the most important buildings in the world because of the provision of educational services to students throughout time. Schools use a lot of energy to ensure that the facility is safe, secure, comfortable and conducive to learning for students. Everything from lighting to climate control adds to the electrical expenses related to running a school. Owing to the containment of a large number of occupants (students and trainers) for long periods of time, this leads to the depletion of large amounts of energy and resources in order to provide a comfortable indoor environment for the users. Teachers can consider energy-saving efforts at school as an option to work with the students. Children in the classroom can help to create innovative ideas to save energy at school. Engaging children in energy-saving processes at an early age encourages responsibility and begins a life of environmental awareness. As a general practice in developing and underdeveloped countries, the school buildings are designed by not considering the thermal and visual comfort requirements that must be provided in an education building. In these countries, most of the school projects prepared are projects that are designed by governmental institutions. In these projects, the passive design parameters such as orientation, Window areas, form factor, etc that will improve the indoor conditions are generally not employed. The projects are applied to any place without considering the local conditions. Hover, in the literature, there are many studies focused on improving the performance of these buildings.

Recent advances in technology, the transfer of energy resources and advanced building materials have helped to create different building solutions. Hover, many of these solutions drain the planet despite the use of new technologies. With natural resources such as the sun, wind, the topography of the earth, there is also the available building materials and their adaptation to the social values, customs and traditions of society to consider.

It is clear that there have been major essential changes in the process of school buildings in the world and this requires reconsidering the process of designing school buildings in Iraq generally and the city of Kirkuk particularly, for the reason that many countries of the world to pay attention to the establishment of sustainable green schools in order to evaluate schools according to environmental standards. The research consideration pays attention to energy consumption by reducing the cooling and heating loads and by considering natural lighting according to the Iraqi standards. As well as thinking about the orientation of the building to the four directions, considering the different shapes of the building in order to choose the best simple model for energy efficiency in the school building in the geographical situation in Kirkuk / Iraq is also important.

Iraq's building sector uses a lot of energy without indoor climate comfort because the building's envelope is not tightened by insulation. In the building permits of Iraq, there are no regulations that focus on energy use per year such as any other developed country by the Ministry of Housing and Construction and the Ministry of Planning of Iraq [6]. Most studies in recent years agree that pollution rates in the air are increasing with more risks to human health as pollution is linked to disease risk. Buildings are the main contributors to energy consumption and carbon emissions. Now it is clear to the regional administrations, architects and engineers that the building sector in Iraq has to take on the responsibility to meet commitments and to fulfill its developmental role without causing pollution. This study shows the importance of the role of architecture to treat such problems. This shows that in turn, more attractive trends resort to the use of renewable energies or they seriously consider alternative energies to meet future needs.

1.1. Energy and Natural Source Problems in Iraq

The identification of the energy problem in Iraq and the world threatens to lose the most important elements of the infrastructure. The problem of energy in Iraq has been and continues to be a problem due to the natural and human factors. Incorrect policies have separated Iraq from the world for many years as a result of successive wars [7]. Today, the energy issue in Iraq generally is one of the main problems facing the state, including the cooling and heating of the buildings and the electricity crisis in particular. It is losing so much energy that electricity generation in Iraq is between 10-15 hours per day at present [8]. Since most of the buildings in Iraq are not insulated, buildings consume a high amount of energy that includes the various natural source material components for energy that is used to obtain interior comfort in buildings. The instruments used in Iraq for heated and cooled buildings indoors lose a lot of energy such as electric heaters and halogen tubes which convert electricity into heat energy by using halogen. This type will lose energy during conversion and split systems HVAC. One of the big disadvantages of split use is that it takes a lot of electricity to operate the system. Kerosene heaters emit a lot of gases into the building indoors or in the atmosphere. This poses a danger to the environment and to health due to pollution as well as unpleasant smells.

These factors make the energy consumption very high, especially with the increasing consumption due to the rapid population growth and the need for building excessively. On the other hand, there is the problem of the rapid depletion of energy supplies, as well as the mandatory energy requirements for buildings and life. Most of this energy is wasted due to the misuse of the user and the erroneous design of buildings.

In Iraq, the issue of energy conservation needs to be upgraded and there needs to be the protection of public liability resources. These are the key factors that raise the awareness of problems in terms of the energy consumed in the buildings as follows.

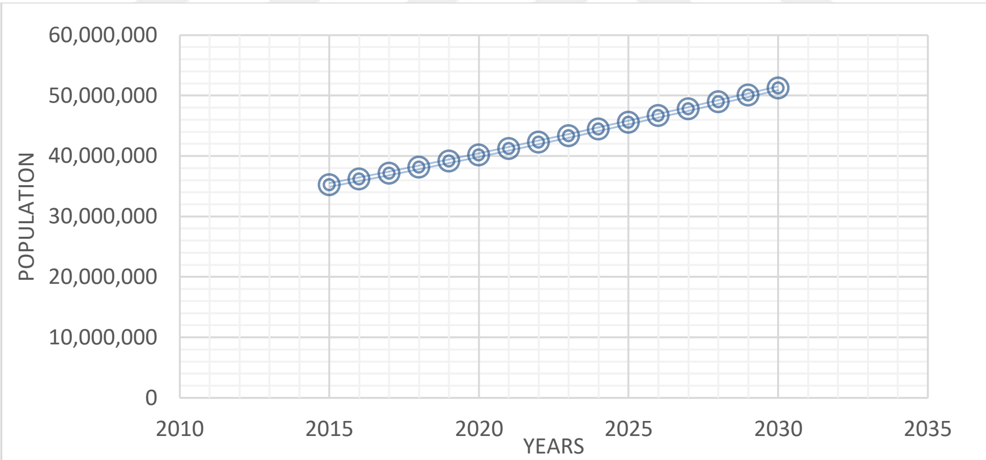


Figure 1.1. Estimates of Iraq population for the period 2015-2030.

1.2. Increasing Population

The population increase is one of the main causes of energy problems in Iraq. This leads to demands for increasing services from the population due to the lack of energy needed, whether this means electricity, water or a lack of heating and cooling for buildings. This affects all of the provinces of Iraq, including the city of Kirkuk. By 2030, Iraq's population will be 51 million according to the data from the Ministry of Planning, which is the Central Statistical Organization (CSO) [9] as seen in Figure 1.1. According to the data from the Ministry of Planning and according to the figures from the Ministry of Planning until the end of last year, included Kirkuk, it is the fifth largest city in Iraq located in the center of northern Iraq. The population is 1,626,000 people.

1.3. Electricity Requirements

The disarray of consumption, the lack of realizing that there are readily quality materials available and the lack of awareness of the importance of the building culture in addition to the return to building materials and suitable designs that are relevant to the environment of Iraq means that the Iraqis suffer from the summer heat and the cold winter. There is also a lack of energy, especially electricity power. The issue of electricity shortages is not new. Since 1991, Iraqis have been suffering from almost constant power cuts under the heat of the summer and during the winter cold.

The chairman of the Iraqi Engineers Association in Germany explained that they attributed the reason for the lack of electricity in Iraq to worse planning. According to him [10], the poor state of the planning was due to the early eighties in the last century. Several factors have affected the planning of a proper electrical system in Iraq including wars and economic boycotts in addition to political and economic instability. A lack of planning means a lack of future production and the inability to maintain electricity stations. It is a major reason for the shortage suffered by Iraq up until now. must not forget that modern man consumes more energy as a result of the entry of modern devices and technology into homes.

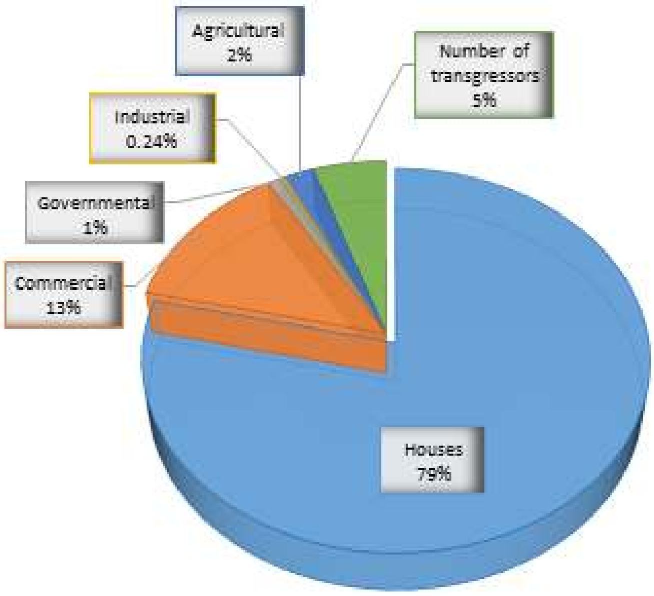


Figure 1.2. Percentage of consumer preparation by category.

According to the schedule on the Ministry of Electricity bsite [11], it shows that Kirkuk governorate houses use much more electricity compared with other categories of housing. In Figure 1.2, it can clearly be seen that building construction in Iraq is not concerned with saving energy.

1.4.Traditional Construction Techniques

One of the main reasons for the lack of energy is not keeping it in the building. The building method in Iraq is catastrophic. The materials used are cement, concrete and block without any insulation. This kind of traditional building has a high U-value. This means that there is a loss of a lot of energy inside the building, and the nature of Iraq ather is hot and dry in summer and cold in winter.

It is known that in construction in ancient times, the buildings re built with clay, stone, grass and wood. These are materials from the heart of nature. "The style follod since ancient times depended on physics in the building. The method that is currently used to build is a floor, walls and roof without insulation and without paying attention to the calculations of heating and ventilation, or the calculation of openings for natural lighting. The indoor environment is important." This way that the building loses heating in the winter and cooling in summer, it pays a lot for the energy requirements, especially the need of electric power.

1.5. Water resources for cooling systems

The Iraq ather is mostly hot during the year, therefore there is often a focus on cooling systems more than heating systems. The hot ather in Kirkuk city is between (May - October), therefore it uses a lot of water resources for cooling the building through the needs of an energy-powered device. Two cooling systems are typically found in Iraq that are used for indoor cooling in the buildings [12][13].

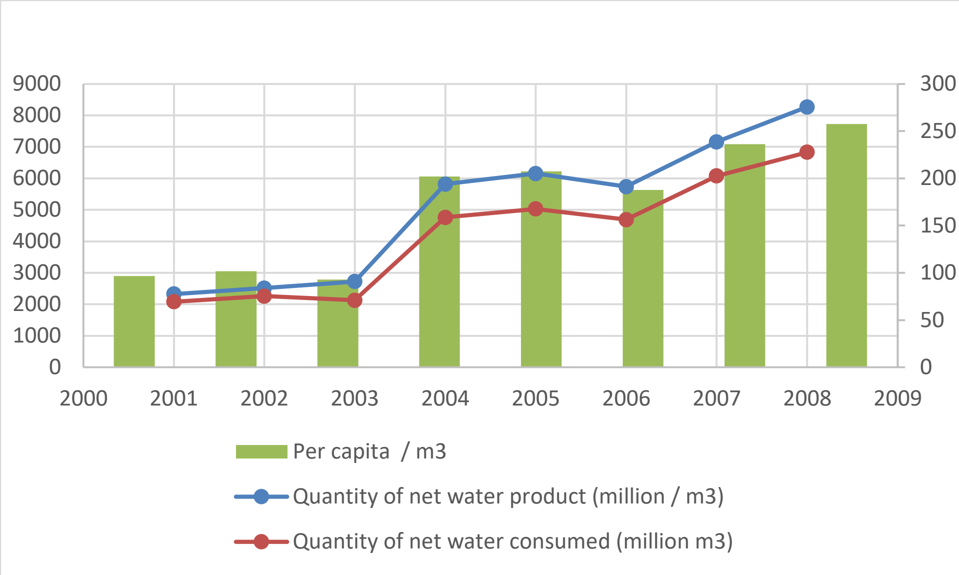


Figure 1.3. Quantity of water produced and consumed in Iraq.

The criteria used to measure the average daily water consumption of cities in Iraq shows that all urban production and service sectors tend to have excessive water consumption rates. This is increasing due to the increasing growth of the population and the different economic sectors at the same time, as in Figure 1.3. Understanding the use of water in an enterprise is imperative to prioritizing areas to appropriately focus both time and resources. Using the water efficiency manual for the state of North Carolina [14], [15] gave example data related to the water distribution (water balances) for schools as in Figure 1.4. Each facility should determine its own unique water balance to best target savings opportunities.

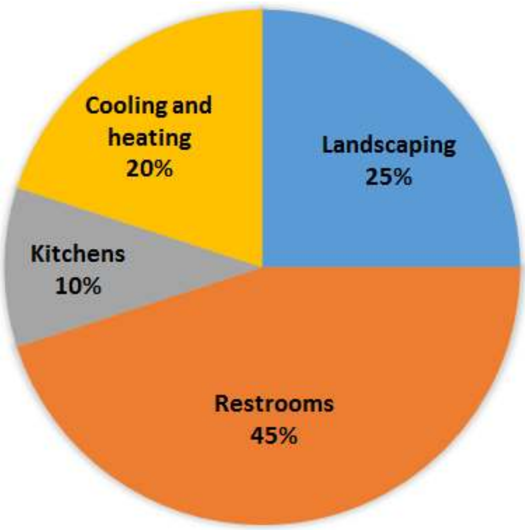


Figure 1.4. Water Usage at Schools.

1.5.1. Heating Energy Requirements

It is important to obtain a good internal environment that meets the needs of human physiology and health, as well as to provide a kind of luxury needs related to a good ventilation system inside the buildings. In fact, the function of any ventilation system is not to supply oxygen but to get rid of carbon dioxide, moisture and unpleasant odors as well as particles in the air. There needs to be a system to supply places, people and water at the right temperature, especially in times of increasing cold. As winter approaches, temperatures drop dramatically and the need for heating inside the buildings increases, especially if the rooms are used frequently, such as the living room, office room and classroom. This applies more to those that do not have a fireplace. Because of the building envelopes not being tightened in a good way, buildings in Iraq are losing a lot of energy. They use an internal heating system that consumes a lot of energy such as white oil heaters, electric heaters and a split system. Central heating provides warmth for the interior and most developed countries have used this system to heat their buildings. Hover, this system does not work for buildings in Iraq because the building envelope is not insulated, resulting in thermal energy loss. The cost of heating energy generation is one of the main operating costs of the building in cold climates. Water heating is a heating system for homes, offices and schools in a safe and easy manner. Central heating is one of the safest ways to heat places because of its low risk to property and people. Very few buildings have this type of heating in Iraq. In terms of efficiency, a large proportion of the heat is lost and wasted if only one room is heated in the building. There is a loss of heat during the distribution in the central heating system and during the heating of uninhabited areas. In buildings that require thermal insulation, a decentralized system such as the separate heating of rooms, fireplaces and other systems can be taken into account. Architects have been using alternative ways to reduce the need for energy for heating and cooling by complying with Germany's non-mandatory laws called the Passive House Standard [31]. If the building requires full heating, then the heat generation from the combustion process is more environmentally friendly than electric heating. Typical rates for the central heating system (percentage of consumption) are as follows:

- 65-97 % for gas heating
- 80-89 % using oil
- 45-60 % for coal heating

As a result, in Iraq, it is not difficult to find a new energy supplier in addition to the traditional energy of an oil-rich country suffering from an increasing power shortage and the failure to meet the growing demand for energy due to a limited production capacity and many disadvantages. Interest in renewable energy sources such as solar and wind power has increased and Iraq is expected to be one of the richest countries in terms of renewable energy resources due to its unique geographical position.

1.6. Studies Related to the Topic in the Literature

In the literature, there are many studies on the parameters that determine the energy needs of both schools and other buildings with different functions and the ways to reduce this need. Some of them are listed below.

Pan et al. [17] developed energy modeling strategies for high-rise buildings based on the state of public housing in Hong Kong. They revied the barrier knowledge that prevented the use of energy analysis software for building and proposed a workflow to integrate energy simulation into the design phase.

According to Larsen and Toubro [18], building performance was assessed for all measures using the Energy Simulation Program of the Green Building Studio. To improve on the direction of the building and to provide maximum openings in the north and south, based on the solar exposure analysis, part of the building is oriented in such a way to receive minimal direct solar radiation. The sun's path analysis was performed to determine which part of the façade is the most important for solar exposure and the window opening was optimized based on both visual and thermal comfort.

Schlueter and Thesseling's [19] article focuses on the energy performance of buildings. They expanded the analysis of shared energy by considering the thermal economic concept. It provides a balance between the shape of the building and the materials and technical systems involved. This makes a comprehensive view of the building possible. The building information model is used to store the necessary data and to access parameters during the design process. The energy and liquefaction calculations are integrated directly into the building information modeling editor using a typical tool. The tool provides a quick estimate of the energy performance of the selected design, facilitating the necessary parameter input using non-expert decision criteria. The results are visualized using the specific key performance indices and graphical visualization.

Kumar et al. [20] stated that building models are designed using a design builder. The building models re designed using building materials such as rocks, dense concrete, burnt bricks and mud bricks. Using different glass materials with various window to wall ratios, the window glass was placed in all four directions. The building models re then evaluated for thermal performance in order to reduce the cooling loads. Controlled heat gain in buildings can be done using suitable glazing and wall material combinations. The results also showed heat gain in building increases with an increase in the window to wall ratio. It also showed that the heat gain was minimal in the south orientation compared to the other orientations.

Kota et al. [21] emphasized that daylight is an essential aspect in the design of high-performance buildings. They performed daylight analysis using either manual calculations or computer simulation tools. The integration of BIM with building performance tools has been the main focus of both the developers of the BIM authoring tools as well as the Building Performance Simulation community.

Lagüela et al. [22], in their paper, showed that 3D models are proposed to be used as inputs in the lightning analysis given their adequacy of providing information about the geometry and the building parameters. Moreover, a methodology is introduced for their generation which is taken as the basis for geometric information on the reality of the building, obtained only using a laser scanning device. The methodology of the work to automatically generate 3D models of the interior rooms and their components using the gbXML scheme can be explained by applying it to a case study chosen by representing the reality of the buildings. This gives great importance to the natural lighting of the entrance elements, such as windows and glass doors. It displays the results of using the 3D model for daylight analysis.

Kim et al. [23] showed that the development of the Modelica library introduces the simulation of building information modeling (BIM). This is based on building energy using the object-oriented physical modeling and Modelica approaches. The ability to import building geometric and thermal construction data from BIM has great potential to reduce time and uncertainty in the process of building energy models.

Abanda and Byers [24] examined the effect of the orientation on energy consumption in small scale construction and they assessed how building information modeling (BIM) is used to facilitate this process.

Harmati and Magyar [25] presented a detailed analysis in an attempt to improve building energy performance in terms of the impact building envelope on the annual demand for heating and cooling. The envelope of the building was examined in order to determine the proportion of the windows to wall ratio (WWR). Window geometry (WG) in the function of indoor daylight quality in offices can be assessed by the numerical simulation of the Radiance engine, follod by the assessment of the effect of glazing on annual energy demand.

The Guide and General Rules for UAE Green Buildings [26] shows that the new buildings have high windows to increase their use of natural daylight in the interior and to reduce the dependence on electric light during the day.

Reducing the demand for HVAC and the lighting systems through the efficient use of free natural resources is a good way to conserve energy. Biao Sun [27] provides integrated control in HVACs, lights, curtain shading and natural ventilation to minimize the total daily energy cost.

Ouf and Issa [28] aimed to measure historical energy consumption over a 10-year period from a sample of 30 school buildings in Manitoba, Canada. It showed that the average energy consumption of these schools was higher than that of other Canadian standards. Molina-Huelva et al [29] carried out experimental tests on two school buildings in southern Spain that analyzed the effectiveness of air regeneration through a mechanical ventilation system compared to the natural ventilation system. They studied indoor CO2, temperatures and humidity in terms of classroom occupation. After the analysis, the measured data was validated by running the simulations in the third school building where Natural Ventilation Systems (NVS) re designed and overlapped with the stacking effect.

The SBM has a high-performance building envelope and energy efficiency requiring low power to run the electrical systems. Bennani and Bensaadout [30] found out that the application of energy efficiency measured in a baseline building demonstrates a 56 % reduction in the energy efficient building model. The combination of double-photovoltaic glass and the cover of the proposed model reduces its consumption by 15%, making it a positive model for building energy.

Sharma and Gidwani [31] showed that a 234 kW solar photovoltaic system that is grid-connected can generate a sufficient amount of electrical power compared to its consumption. It can mitigate the energy consumption from the grid supply and reduce the grid dependence using the PV*SOL premium simulation tool for the campus hostels of Rajasthan Technical University (RTU), Kota, Rajasthan, India.

Holdermann et al [32] provided the economic feasibility of small-scale, grid-connected photovoltaics in Brazil's residential and commercial sectors after the introduction of the net measurement system in April 2012. The study used the discounted cash flow method to calculate the specific investment costs necessary for photovoltaic systems to be economically viable in each network of the 63 distribution in Brazil. They obtained a second important parameter by simulating the PV-systems with the PV * Sol software and the distribution of the company's headquarters locations.

Patarau et al [33] provides technical and economic analysis and optimization of hybrid renewable energy system consisting of solar panels, batteries, geothermal power generator, and biomass generator in the area of Oradea, Romania which aimed to provide a vegetable greenhouse. The renewable energy system has been optimized using the PV * Sol program.

Sii Lou [34] presents energy-saving designs in the school building, simulating energy expenditure and discussing the results and design implications. High-performance building envelopes, energy-efficient air conditioning systems, lighting fixtures for energy consumption and built-in BIPV panels have been used to meet the energy requirements.

This thesis consists of 9 sections which include the theoretical knowledge about the passive and active architectural design strategies that will be helpful in developing an SBM for the Kirkuk /Iraq region.

In the 1st section, the energy requirements of the building sector and the effects of the energy efficiency approach and the role of architect/ designer have been discussed. The energy requirements of Iraq and the importance of providing comfort conditions in school buildings have been explained and a literature review about the topic is given. Finally, the aim and the method are briefly explained.

The problems of energy and natural resources in Iraq through the increase in the population in Iraq has led to an increase in the use of electricity for various purposes, especially for cooling and heating buildings. There is also the increase in the use of water for cooling in the summer and the increase in pollution through the increased energy use.

In the 2rd section, architectural design affects the energy efficiency in the buildings. Passive design increases the use of natural energy sources for heating, cooling and ventilation to provide comfortable indoor conditions. The environmental and the buildings own parameters that affect its energy balance are comprehensively given. The method and the sample building model are presented and different scenarios re prepared to see the effect of the different parameters expressed.

In the 3th section, the renewable energy and solar energy application provides photovoltaic panels using the pvSOL software on the top roof of the SBM. It is renewable energy that is friendly for the environment without producing pollution. This section also discusses the impact of solar energy on Earth and the exploitation of this energy to generate electricity in the building design.

Methods created by using various software for energy analysis using BIM tools (Revit and Green Building Studio) related to simulating heating and cooling. Autodesk 360 Rendering has been used to display the electric and solar lighting directly in the Revit model. Dialux Evo has been used to provide sufficient daylight inside the building. The PV*sol program provides excellent support for the evaluation and design of photovoltaic systems.

In the 4th section, the application of the study was used to create various scenarios for the properties SBM design and the effect of building location, building forms and building parameters such as the impact of window area and daylight on the building.

In the 5th section, the results and the discussion of the energy requirements of the heating, cooling, lighting consequences obtained from the different scenarios generated from the same simulation of SBM have been given in the tables and figures. The results are comparatively discussed.

In the 6th and 7th sections, the conclusion, recommendation and references has been presented.

1.7. The aim and the objectives of the study

Schools are considered to be the second home of students. The school is more than just a place where children go to study. Rather, it is a place where a child lives for almost half of their waking hours during the tlve formative years of their childhood. It is clear that in Kirkuk, the comfort conditions in the school buildings are not considered during the building pre-design stage. Some commercial buildings re converted into school buildings without much attention being paid to the environmental aspects. The design and internal comfort became a commercial target, which affects the students and their ability to listen and attention. This study looks for appropriate solutions that will cause less energy requirements in terms of heating, cooling and lighting in a school building sample assumed to be in Kirkuk city. This is intended to:

- Upgrade the level of the school buildings.
- Make the school buildings efficient in terms of energy and to provide a healthy internal environment for the students within the school buildings in terms of energy efficiency.
- Highlight the existing school buildings and provide a realistic study of schools that are not compatible with the environment. This is in order to improve the performance of the internal climate.

The following objectives are targeted to be achieved at the end of the thesis.

1- To provide the students who are interested with information on identifying the components of the school building, the operations of the building envelope and the requirements of the internal environment of the building in order to improve the performance of the comfort conditions.
2- To build a knowledge base on the importance of the use of insulation materials in the school buildings, providing the benefits of the immediate and future. There is no use of the isolation requirements in the buildings in Iraq generally and in Kirkuk especially.
3- Evaluation of the school buildings related to how to use the energy monthly in a manner that is commensurate with the environmental standards and the rise of civilization, keeping pace with global developments.
4- To create a roadmap for reducing energy consumption using renewable energy sources in school buildings.
5- Clarifying the possibility of transforming educational institutions into a kind of environmental reserve and the elimination of global warming.
6- Instill awareness of the environmental issues in the students and strengthening the sense of responsibility and community.

For designing healthy schools that are comfortable, interactive and responsive to the environment and safe, the following steps re carried out.

- Evaluation of the appropriate building form factor from among the different alternatives.
- Modeling the school building sample, the determination of the location and the building components to make simulations using the Revit program.
- Calculation of the monthly cooling, heating and lighting energy requirements of the building.
- In addition, making simulations using the Dialux Evo program for daylight calculations within the building, which aims to improve the performance of the student’s visual comfort in schools, and also decreasing the amount of energy used for lighting.
- To evaluate the performance of a photovoltaic system that is assumed to be installed on the rooftop of the building is analyzed.

2. ARCHITECTURAL DESIGN OF ENERGY-EFFICIENT BUILDINGS

Our planet is heated by human activities that affect the environment. The building sector is one of the activities that are supposed to reduce the use of energy to protect the environment. The appropriate thermal design of the building envelope reduces the heat and cooling loads required for heating and air conditioning (Figure 2.1). This determines the use of low-cost, low-operational heating and cooling devices. The objective is to reduce the cost and energy consumption and to provide a comfortable claim within the building. Reducing the energy use in buildings will certainly reduce pollution. Architects and engineers play a key role in solving the associated problems. Energy-efficient buildings (new buildings or existing buildings that have been renovated) can be defined as buildings designed to significantly reduce the energy requirements for heating, cooling and lighting [35], in addition to establishing independence in terms of the energy and equipment that is to be selected for heating or cooling. By considering the following strategies, energy efficiency can be achieved in the design of buildings:

- Designing the buildings form and orientation according to the environmental sources (utilizing the sun, wind, vegetation etc).
- High performance building casing through insulation, high-performance glass windows, air-sealed construction and avoiding thermal bridges.
- The high performance of controlled ventilation, mechanical control and heat recovery.

The modern era has been characterized by overlapping and contradicting its complex requirements within the various activities. This characteristic has become a feature of civilization development. The world today is changing profoundly and with great speed. It has seen unprecedented quantitative and qualitative transformations, which calls for an extraordinary effort to understand the process of change that is now underway. The rapid growth that has occurred in recent decades has been accompanied by a number of building activities that have caused an impact and influence between architecture and other disciplines.

On the other hand, the inevitable result of development and growth and the need to meet the necessaries of the new functions is related to the increase in energy consumption in the world and thus the increased use of fossil fuels (coal, oil, natural gas) significantly. Fears of depletion have led to environmental pollution [37], which calls for the need to reduce consumption in the form of energy-efficient buildings.

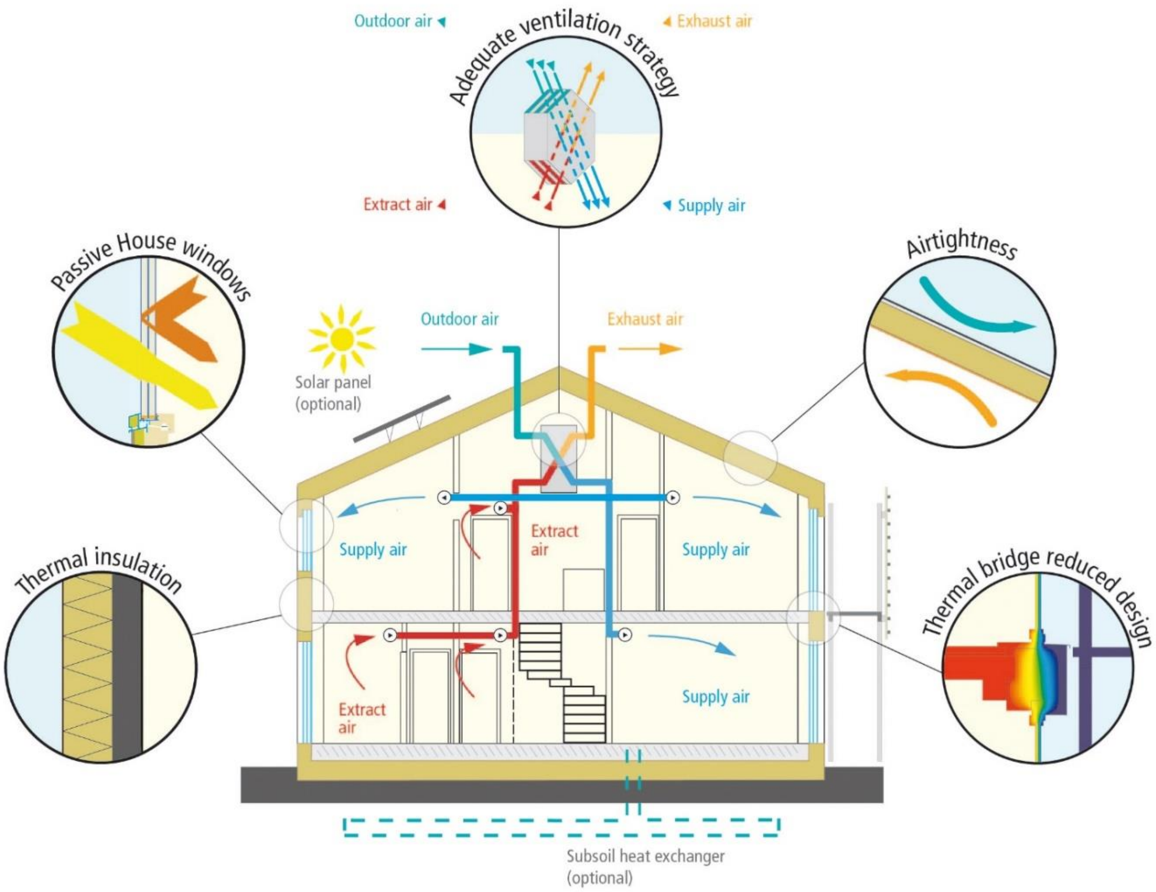


Figure 2.1. Five basic principles apply for the construction of passive strategic design [36]**.**

It is possible to conserve energy in building design through two aspects. The first is reducing the need for energy use through designs that take climatic conditions into design considerations during the design itself, which is known as passive systems (passive design). The passive design increases the use of natural sources for heating, cooling and ventilation in order to provide comfortable indoor conditions. The harnessing of environmental conditions such as solar radiation, cold night air and air pressure variations can be used to drive the internal environment. Passive measures do not involve mechanical or electrical systems. The second is to increase technical efficiency and to use it to serve the architectural work. This is known as active systems (active design) such as the emergence of modern air-conditioning systems that consume less energy compared to the previous devices.

Designers adjust the thermal properties of buildings to mitigate external environmental conditions and to maintain internal conditions using minimal materials and fuel resources. The key to designing a passive building is to take advantage of the local climate (microclimate). Thus, climate characteristics and classifications help to identify early approaches such as site planning and analysis. Climate and comfort are the two main scales of passive design that require attention. Passive design is a key part of environmental design, employing many techniques and strategies that can be used in buildings in all types of climates around the world, such as orientation, ventilation, shading, thermal mass, insulation, daylight etc.

These techniques and strategies can also be supported by different parameters such as the use of passive and/or active techniques and customizable controls as well as enhanced patterns for biophysical design to improve health and all-being in the building environment. The optimal design of buildings should aim for:

- Energy saving related to heating-cooling and lighting.
- Reducing heat losses and overgains.
- Reducing the cost of the establishment and maintenance of HVAC systems.
- To ensure that the conditions of the thermal satisfaction and the health of the occupants of the building are met throughout the seasons.
- To avoid condensation or reduce it on the internal surfaces of building in the cold areas when using heating and avoiding the damage caused by it.
- Reducing the cost of periodic maintenance resulting from the thermal stresses of the buildings.
- Extending the investment life of the building.
- To provide effective and efficient use of lighting for saving energy and reducing costs.

2.1. Causes of Energy Requirements in Buildings

It is clear that rapid technological development has changed the Iraqi way of life after the industrial revolution and it has reflected this development in the style of the design of buildings, their specifications and characteristics and it has also increased reliance on the mechanical means to achieve comfort within the different spaces. Hover, technological development has had negative impacts as ll, which have been reflected in the significant climate changes worldwide. The temperature in the climate has increased which has affected the comfort requirements and increased energy consumption. Energy use in buildings represents a large proportion of the total energy use.

When the students are dissatisfied with their thermal environment and visual comfort, this does not represent a potential health hazard that affects their ability to study effectively and their satisfaction with teaching. Thermal and visual satisfaction for the students in the classes is the students' complete feeling of physical and psychological comfort due to the surrounding thermal environment and visual lighting within the spaces. The lighting is changed according to their age, location and the climatic season.

The exterior color of the surfaces determines their ability to absorb direct rays. The lighter the color, the greater the ability to reverse direct rays.

2.1.1. Thermal comfort in buildings

Thermal comfort is an element of the quality of the internal environment. This is because it is one of the most visible characteristics of the internal environment, especially when improperly designed, which is one of the most important physiological factors that strongly affects the case of the students. The state of the environment is determined by the extent of the body's ability to get rid of temperature and humidity to achieve a balance between what the body loses or acquires from the mutual heat with the surrounding environment in order to achieve a sense of comfort or to get away from it. An imbalance can lead to damage and presenting a danger to health.

Thermal satisfaction is related to the ambient air temperature, relative humidity, air movement, average radiative temperature, clothing, the student’s activity nature and the design of the heating and cooling temperature. The school building envelope does not conserve energy inside the building, causing an uncomfortable and unhealthy indoor climate for the students. Students are supposed to wear lots of clothes or even sit with their jackets on during the lesson, which makes the students uncomfortable. Thermal comfort is a basic requirement that must be provided in buildings and is one of the most important factors affecting human activity and its productivity in terms of quantity and quality. It is necessary for the students to feel comfortable inside the building as contemporary kids spend most of their day in school.

2.1.2. Visual comfort in buildings

The theme of visual comfort is an exciting challenge when designing a comfortable visual environment using an appropriate level of shading and adjacent surfaces to move the light from light to darkness without sudden fluctuations. Both natural and industrial lighting and their distribution must, therefore, be considered during design. It must be preferably smooth in their properties and thoughtfully distributed throughout the space.

The directivity of light in the space of the worksite has a great impact on the visual comfort to be achieved within the space. If one does not to take this design under consideration, then it can cause a state of discomfort or it can be dazzling, which hinders visibility. It can also reduce the ability to view details and objects due to the improper distribution of lighting or because of the extreme range or high contrast in illumination [38].

Every human activity needs a certain amount of lighting. The level of lighting required is affected by the type of activity itself and the speed required for completion. The direction of the light source, the speed of the movement of the perspective part and the difference between the place of the student and the whiteboard in the classroom [39] all need to be considered, which ensures that a good study environment or optical field provides visual comfort that is suitable for the completion of the activity without stress or exhaustion.

Identifying the appropriate levels of lighting required is the general consideration of the starting point of any lighting design. The Illuminating Engineering Society (IES) recommendations for lighting levels are as in Tables (2.1) for both general tasks and special tasks. The level of illumination is usually measured at a height of (78-85) cm above the space floor.

Daylighting can reduce the use of artificial light and its electrical equipment. In all of the spaces in the school building model, it provides daylighting and an architect can choose glazed areas for the facades of the exterior building to ensure that there is plenty of daytime lighting and distribution. Interior spaces in the buildings will be exposed to sunlight enough to ensure the health of the place. It will receive a healthy amount of sunlight and daylight in accordance with health standards. The target is to reduce the energy consumption of the building and to reduce the electricity generation capacity to save energy, to reduce carbon emissions and to reduce the risk of building-related diseases, thereby reducing the long-term building costs and operating costs. There are no general methods that include everything in one formula or number. The daylighting design needs to consider the orientation characteristics and location of the building, the characteristics of the façade and roof and the size of the openings of the windows, in addition to glazing and shading systems, geometry and reflection.

Table 2.1. Standards of lighting level for spaces in different types of buildings.

Space type	Light level (LUX)
Rooms for keyboards and contacts	500
Manual ironing,	300
Markets	500
Big markets	500
Theaters	100
Cinema	50
multipurpose hall	500
Lecture hall	500
Writing panel	500
Seating space	500
Exam halls and discussions	500
Laboratories	500
Workshops (educational workshops)	300
Teaching rooms and student rooms	300
Book shelves	150
Reading Tables	300
Reference space (titles of books)	500
Bookstore	100
Corridors	100

2.2.The climatic conditions effecting building design

The most important effects are related to human life and daily activities. It was and still represents the greatest challenge to humans; man is trying to adapt to the natural climate. With the passage of time, the diversity of civilizations and scientific and technological progress, man can understand both natural and environmental phenomena and their geographical and climatic characteristics. He can arrive at positive solutions in design so then it is suitable with climate. It is necessary to study the climatic elements that interact with humans and the effect on thermal performance [40]. The most important climatic factors that affect humans and that interact with the building expined below.

2.2.1. Solar Radiation

The Earth gets solar energy through solar radiation. This radiation energy comes to us through tiny, ightless particles called photons. Solar energy is responsible for all processes in the atmosphere such as airstrikes, clouds, rain, wind, lightning, thunder, etc. It is also the main cause of the continuous movement of the atmosphere and ather variability and change, and the main differences exist between places in terms of the abundance of solar energy.

Direct sunlight enjoys critical importance in relation to architecture - for aesthetic reasons, experience, and comfort, as well as for energy performance. It can increase the direct sunlight for heating in the winter but it can prevent cooling in the summer. Direct sunlight can provide warmth and dynamism for spaces, but it can also mean the visual or thermal discomfort of diverse occupants such as office workers or students inside the school building.

2.2.2. Outdoor Temperature

The outdoor temperature is an important factor in terms of the energy balance of the building. External air temperature affects the heat transfer through external walls and roofs and heat transfer through the ventilation. In addition, the external air temperature is a driving force for natural ventilation. Temperatures in Iraq in general and in Kirkuk are very hot, as it may exceed 49 degrees celsius in mid-summer. In the cold ather, it will be 5 degrees celsius.

2.2.3. Humidity

The monthly change of humidity at the meteorological station shows that in the period from (2012-2018), the lost value of humidity is in June Figure (6.1). The relative humidity in the city of Kirkuk for the year 2017 seems to have different values for the maximum and minimum boundaries between the days of the year. The annual humidity is (30 %), which is a varying value that is inversely proportional to the temperature variations. The maximum humidity appears at 10 am in April and the lost rate is at 7 pm in August. The monthly humidity rates are between (10 %) and (65 %).

2.2.4. Wind

Winds are defined as the movement of air masses due to atmospheric pressure differentials and they move from high-pressure to low-pressure zones. The direction of the wind is according to the geographical direction where it is blowing to, but the prevailing wind direction is the most common trend. The monthly change in the wind at the Kirkuk meteorological station shows that in the period from (2012-2018), it is clear that the amount of wind speed shows the highest quantity in April and the lost quantity in November and December. This is as shown in Figure (6.1). In 2017, the average annual rate of the wind speed is (0.59) m/s. The average wind speed varies slightly, being generally low in January and February with a monthly average of 0.38 m/s. From March to August, it goes above 0.75

m/s and then the value drops from September to December with a monthly average of 0.47 m/s.

2.3. Environmental Factors Affecting Building Design

The environment is an important factor affecting the building. The adding insulation for the buildings, locating the windows in the right direction, using daylight, creating a simulation, the selection of building form and building orientation all allow for energy to be saved and to help the environment. Climate change has become an ecological environmental challenge in the last two decades on every continent and in all sectors around the world. ather and climate are important in relation to the operations and design of buildings in terms of energy consumption. Energy use in buildings is directly related to the climate to which the building is exposed. Hover, the current models of energy use are largely inaccurate in their energy use prediction. One of the reasons for this is the over-simplification of the use of a microclimate in models, due to the lack of realistic models for estimating variations in micro-ather on different building facades. Basic climatic events, such as natural environment, daylight, heat, humidity, and air movement, form the physical environment. A physical environment includes the location, topography, climate factors ...etc.

2.3.1. Topography

The topography of the building site, which includes natural and man-made features, can affect its energy consumption by reducing or increasing the effects of climate impact. Kirkuk is located in northern Iraq between the Zagros Mountains in the northeast, the Lor Zab and Tigris rivers in the st, the Hamrin Mountains in the south and the Sirwan River (or Diyala) in the southst. Terrain surrounding the building (Figure 2.2), for example, can reduce/ increase the intensity of sunlight and wind speed.

2.3.2.Effects of the other structures around the building

Architecture is not an independent building in itself but it is located within a specific region and environment. The region in which it is located plays an important role in efficient building design strategies. While architecture seeks to interact with its environment, technology seeks to maintain the integrity of the environment by limiting the negative impact of architecture on the surrounding environment and providing the energy needed by the architecture from within the regions.

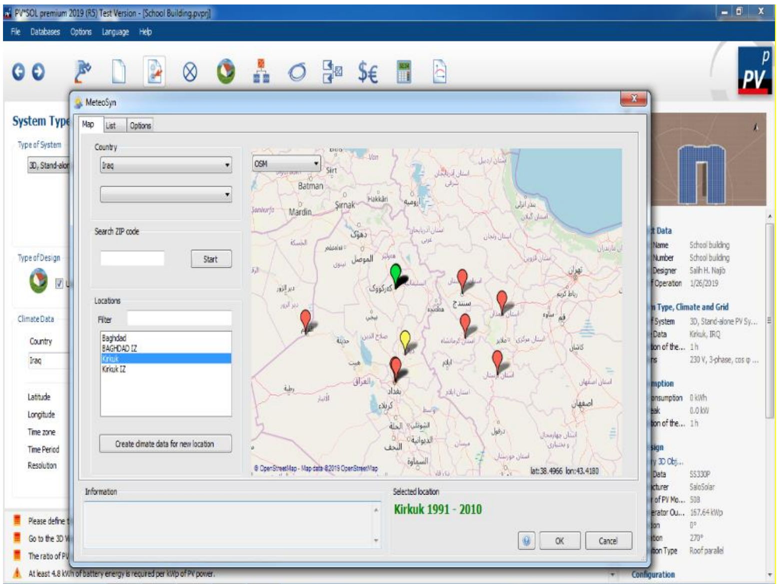


Figure 2.2. Location of building in PV*SOL.

The cross-wind effects of buildings neighbouring and trees have a positive effect on human comfort, wind accommodation, evaporative cooling, air pollution reduction and shading. Taking advantage of tree and tall buildings shade will help to reduce the energy consumption of the buildings during the summer season. Another benefit to companies is the relationship between trees, green areas and human behavior. Trees improve the outdoor comfort conditions within the city by preventing hot and dust-laden winds. Trees can also behave like windbreaks that reduce the speed of ambient wind; the physical characteristics of the building affect the use of cooling energy in the building by lowering or raising it. Since isolation often has a significant impact on the building's thermal balance, shading must be observed by buildings or other objects around the building.

2.3. Factors related to building and settlement

2.3.1. Building Location

The location of the building and the characteristics of the climate in production affect the amount of energy used in the building. The location is an important stage affecting the energy efficiency of the building. For example, if the building is located in a rural area then the use of energy is different compared to a building located in urban areas. A building located on a slope can get a large number of benefits compared to one constructed on a flat site, such as providing better ventilation [41], better light access and achieving the best thermal performance in a moderate climate. Energy consumption in a sloped land location is lor than in a flatland location. It is necessary to know the location of the building and the nature of the city climate and environmental conditions in order to be able to develop requirements that are in accordance with the climate and the environment. The site of the (SBM) building is located at latitude (35.45) and longitude (44.45).

2.3.2. Orientation

Orientation is where to place the building in relation to seasonal changes in the path of the sun as well as prevailing wind patterns. Better guidance can increase energy efficiency in the building, making it more comfortable for the occupants. Good orientation can help to reduce the needs, or it may even require additional heating and cooling, resulting in reduced energy bills, reduced greenhouse gas emissions and improved comfort [16]. The direction of the building refers to the way that a building is located at a particular location. This includes the location of the windows, the rooflines and other features. A solar-oriented building benefits from both passive and active solar strategies. Passive solar strategies use energy from the sun to heat and illuminate buildings [42]. Building guidance and building materials also facilitate moderate temperatures and natural light. Active solar systems use photovoltaic solar panels to collect sunlight and to convert it into electrical power for construction. The external climate influences the direction of the building according to the effect of two factors:

1. Solar radiation and the impact on the walls and rooms in different directions.
2. Ventilation problems that are affected by the relationship between prevailing wind directions and the direction of the building.

2.3.3. Building Form

The shape of the geometric building negatively or positively affects the gain and loss of heating and cooling through the external elements. The greater the area exposed to the external factors, the greater the loss and thermal gain. The designer should consider selecting the appropriate shape of the building by reducing the area of the external walls as much as possible against the side of the building. The heating and cooling will gradually flow out of the building through the external faces of the building (e.g. walls, roofs, terraces). The greater the area of the external faces, the more heat that the place has to escape to the outside. In principle, to reduce heat and cool transfer through the exterior faces of the building, the shape of the building should be as compact as possible.

2.3.4. Thermo-physical properties of the building envelope

1. Thermal Transmittance (U-Value) is the thermal current (in watt) which moves in one square meter of the structural element through its different layers, with a temperature difference of one degree celsius for the air inside and outside of the building or between two different spaces within the building. Knowledge of the value of thermal transition is necessary to decide on the quality and efficiency of the thermal insulation of various elements (walls and roofs) and to calculate the thermal energy loss through the structural elements from inside the building to the outside. The lost thermal transition value increases the thermal insulation capacity and the higher savings in the thermal energy loss is through the outside parts of the building during the heating or cooling period. The thermal transition measurement unit is (W/m^2 K).
2. Thermal Insulating Material: Any natural or industrial substance with a thermal conductivity between (0.10 - 0.01) W/mK.
3. Solar Heat Gain Coefficient (SHGC) is the ratio between the amount of solar radiation hitting the glass window added to the amount of heat loss from the internal surface of the glass by load. The radiation is related to the amount of solar radiation falling on the surface of the glass.
4. Coefficient of Solar Absorptivity is the ratio of the amount of solar radiation absorbed by a surface compared to the amount of total solar radiation falling on that surface.
5. Shading Coefficient (SC) is the ratio between the amount of solar thermal radiation carried out from the used glass and the amount of solar thermal radiation carried out by a single pane of transparent glass of a thickness of 3 mm.
6. Thermal Resistance (R) is the resistance shown by the structural element in front of the heat transfer by conduction through the thickness. An increase means increasing the ability of the structural element to isolate the heat. This value is also called "thermal insulation". Thermal resistance is the inverse of thermal conductance (C). It is calculated by dividing the thickness of material (d) with its thermal conductivity (k) and its unit of measurement (m^2K/W).
7. Thermal Conductivity (k) is the amount of thermal current (watt) that passes perpendicular to the surface of a material of one square meter thickness with a factor of the difference of one Celsius in temperature between its surfaces and the unit of measurement: (W/mK).

3. RENEWABLE ENERGY AND THE APPLICATIONS OF SOLAR ENERGY

Energy is a latent power stored in nature. It is either kinetic energy produced by the wind or waterfalls or electromagnetic waves such as solar radiation. It can be found in the atmosphere of mass reservoirs such as underground heat, which is a power that can be used to accomplish a job that makes it necessary to provide services and facilities that sustain life. In daily use, humans are based on energy sources that can be divided into commercial sources that are usually fossil fuels (coal, oil, natural gas) and non-commercial sources including wood, animal and plant waste. Hover, in the middle of the last century, it was directed towards studying the possibility of relying more on other sources that are an alternative to traditional sources of commerce for energy. These differ in their characteristics in that they are inexhaustible and they do not negatively affect the environment. This is known as renewable sources of energy.

Renewable energy is a major source of energy in the future, not only for Iraq but also for the world. This is primarily due to the fact that renewable energy resources have some advantages when compared to fossil fuels. The sun is the main source of many sources of energy in nature, whether directly or indirectly as shown in Figure (3.1). Each living organism on earth depends upon sunlight for permanence. The solar is considered to be the main source of the vitality of the earth where it provides 99.9 % of the vital warmth needed for various material shapes and living organisms. . It is clean, easy to use, available, reliable and associated with architecture related to solar energy, formal integration and energy saving. The solar is an inexhaustible source and it is one of the most promising energy sources used for generating electricity as well as being environmentally friendly. The average of solar energy represented by solar radiation on Earth is higher than the average energy consumption in the world by around 8000 times [43]. Based on the amount of solar radiation reaching the Earth, the per capita share of energy reaches a very large value of up to 20 MW.

The research dealt with the applications of solar energy as one of the important sources among the sources of other renewable energies Global radiation is an important parameter necessary for most environmental models and it can be addressed as an introduction to various solar systems [44]. But in this thesis, only south openings from passive systems and photovoltaic active system will be discussed.

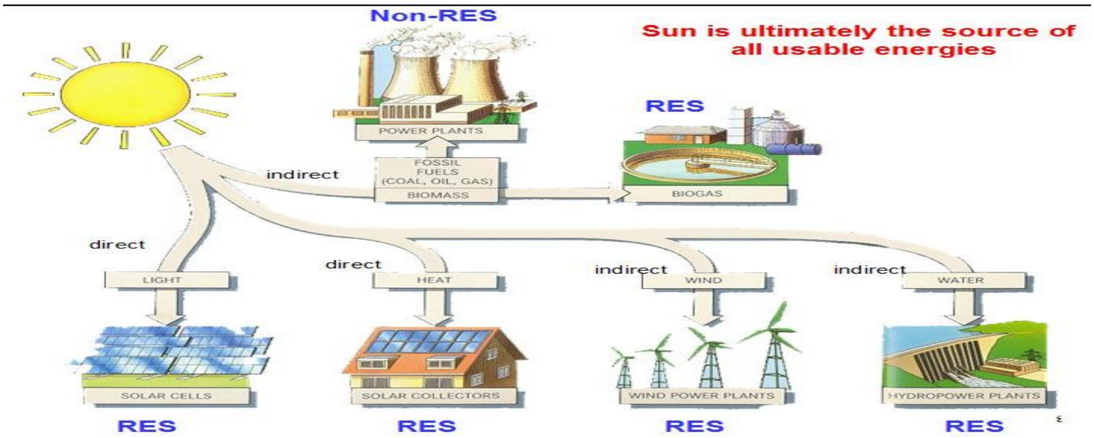


Figure 3.1. Sun is the source of energy [45].

3.1.South Opennings

The opening windows on the southern façade have a key role in improving interior comfort in summer and winter. The windows (glazing) on the south-facing side of the building absorbed the hot sun's energy to heat the building during the winter, and to stay cool in the summer. As the difference in true south degrees expands, the overall solar energy efficiency of windows and structure decreases. In other words, the greater the degree variation from true south, will decrease the amount of the the building's solar gain. As a result, larger amounts of additional energy may be needed to heat the building in winter. South-facing windows (southern solar glazing) are a vital component for the passive solar design and building. Since the south side of the building is the side that will potentially receive sunlight throughout the day, most of the passive solar buildings will have glass that dominates the south side. The south-facing glass allows the sun's energy to be absorbed and distributed through the building's thermal mass. Another advantage of having windows on the south side is that it allows natural light to bathe the building throughout the day. This aspect can also reduce energy use throughout the building since it reduces the use of artificial light.

3.2. Solar Active Photovoltaic (PV) Systems

Photovoltaic solar technology has come to the forefront of energy technologies with tremendous and sustainable growth for more than two decades, with solar power generating around 402 MW at the end of 2017. Solar cells have become reliable devices because they do not contaminate the environment and because they do not produce noise. Because of the global behavior of low carbon development pathways, solar technology is gaining extra importance. For all of these reasons, the use of solar technology is increasing day by day despite the high cost. In fact, there is no ideal system that is 100 %. There must be de-rating factors, whether they are designed or a part of the surrounding conditions.

The environmental problems and climatic disturbances caused by the use of fossil fuels of coal, gas and oil as a major source of energy represent the turning point to the use of clean energy sources [31]. This transformation calls for uniting all efforts to reach it, whether it involves the researchers, workers and consumers, as well as the support required from governments and political decision-makers. For this transformation, one of the most important sources of renewable energy that is the most abundant is solar energy. Solar energy is an inexhaustible source and it is one of the most promising sources of energy to generate electricity and to reduce the emissions of harmful gases. It is a well known fact that the solar energy available at a particular location is not the same throughout the year as well as it varies from location to location. It is therefore important to know the climate data before installing a solar system. Iraq is located between latitudes (29.6 - 37.5) north of the equator, which exposes it to long periods of solar radiation, especially in the summer, which reaches days in length of more than (14) hours. The length of the days during winter is about (10) hours [46].

As the world turns to renewable energy sources, photovoltaic technologies are developing rapidly despite the high cost and complex technology of the photovoltaic cell industry. Hover, researchers are continuously working to integrate renewable energy sources into building design by modernizing these systems. In this study, the performance of a grid-connected PV*SOL as in Figure (25) was discussed and analyzed for the specific geographic location of a school building that was proposed by the model design which was located in Kirkuk.

In this study, building information modeling was integrated with a photovoltaic system simulation. have benefited from integrating the possibilities provided by the architecture software (Revit) with the simulation software PV*SOL for the solar systems. Depending on the BIM techniques used, the top of the roof is selected for the installation of PV modules as in Figure (3.2). One of the most important techniques that assists architects and engineers in sustainable design is Building Information Modeling (BIM). BIM provides a clear visualization of the required designs. The analysis of the solar radiation of the specific site avoids the installation of PV modules in the roof organizer, making them compatible with buildings

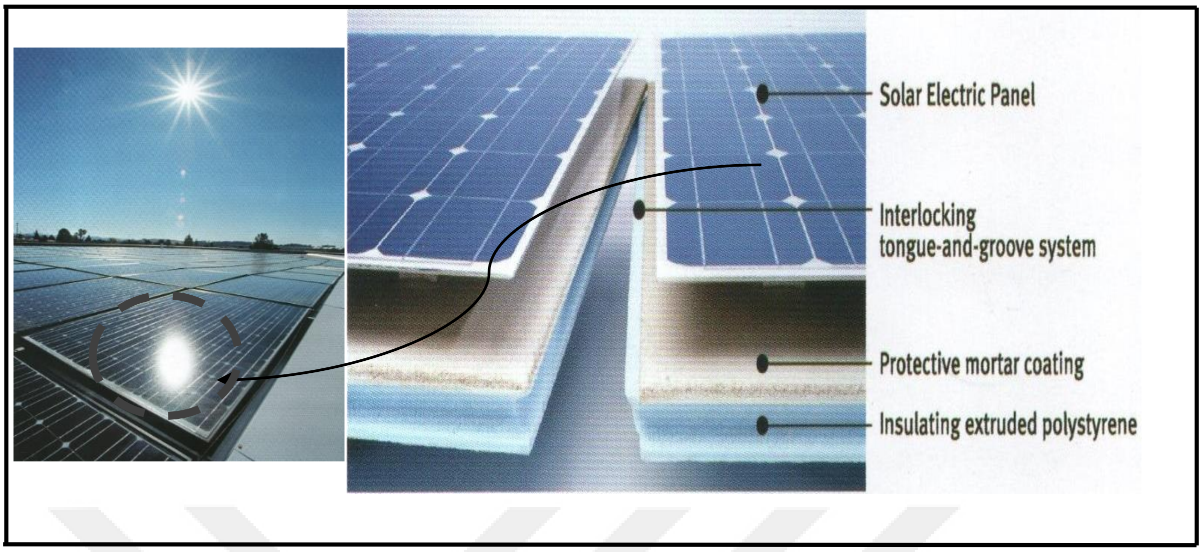


Figure 3.2. PV modules.

4. APPLICATION STUDY.

In this study different passive design parameters are evaluated for determining the best school model that provides most comfortable conditions for the inhabitants in Kirkuk/Iraq. For this reason different building cases are created. The cases differ from each other in their forms, in addition to the window area, window distribution and thermophysical properties of the building envelope. BIM techniques used for determining the energy requirements of the samples. Each samples heating, cooling and lighting energy requirements are determined with simulations. The building samples are modelled in Revit and the energy analysis are carried out with Green Building Studio based energy analysis service for building energy consumption per month. Dialux evo software is employed for daylight simulation of the selected model. And also PV system energy generation is calculated with PV*SOL simulation program. The computer softwares employed in the application study are determined below.

4.1. Softwares employed for the building simulations

4.1.1.Revit

The energy analysis involved cooperation between BIM tools (Revit and Green Building Studio) for simulating heating and cooling and the use of Autodesk 360 Rendering to display the electric and solar lighting directly on the Revit model. The design of the building begins with the start-up phase and it follows the digital representation of the design program in order to obtain a real approach comparable to the final construction product. BIM tools provide digital models that are very similar to reality. During this digital process, the information can be managed throughout the full life cycle of the project through a collaborative environment provided by BIM methodologies and tools. The results are validated against radiance, a commonly used simulation tool, and they are displayed on a canvas more quickly. The service also provides a daylight automated analysis of LEED. The plug-ins for the lighting analysis are released from Autodesk Labs formerly known as the Revit preview of the summer analysis. This helps to create comfortable and ll-lit spaces, reducing the lighting loads and reducing the cooling loads in the pre-design stage of buildings. Designers often use their previous experience and basic rules during these early stages.

4.1.2. Autodesk Green Building Studio

Autodesk Green Building Studio is a flexible cloud service that runs building performance simulations to improve energy efficiency. It works towards carbon neutrality early on in the design process. Green Building Studio will help to increase the ability to design high-performance buildings in less time and at less of a cost than using traditional methods.

Because of the complexity of building energy and mass flows, it is generally not possible to find an analytical solution. Simulation software therefore uses other techniques such as response function methods and the numerical methods of limited differences related to a limited size as an approximation. Most of the building simulation programs used today involve modeling using binding programming languages. These languages assign values to the variables, announce the sequence of the execution of the tasks and change the status of the program as in the Revit and the Green Building Studio Analysis Figure (4.1 and 4.2). One of the biggest challenges of building optimization is the interoperability of the various software tools. From the energy point of view, it is considered to be preferable to include tools with a model platform and an energy simulator (Revit energy analysis).

Green Building Studio performs validation testing as a routine part of each release, including the industry-accepted test ANSI/ASHRAE Standard 140-2011 [47], as well as the internal Analytical Results Regression Testing and the Vasari/ Revit Conceptual Mass Model Energy Simulation Results as in regression testing.

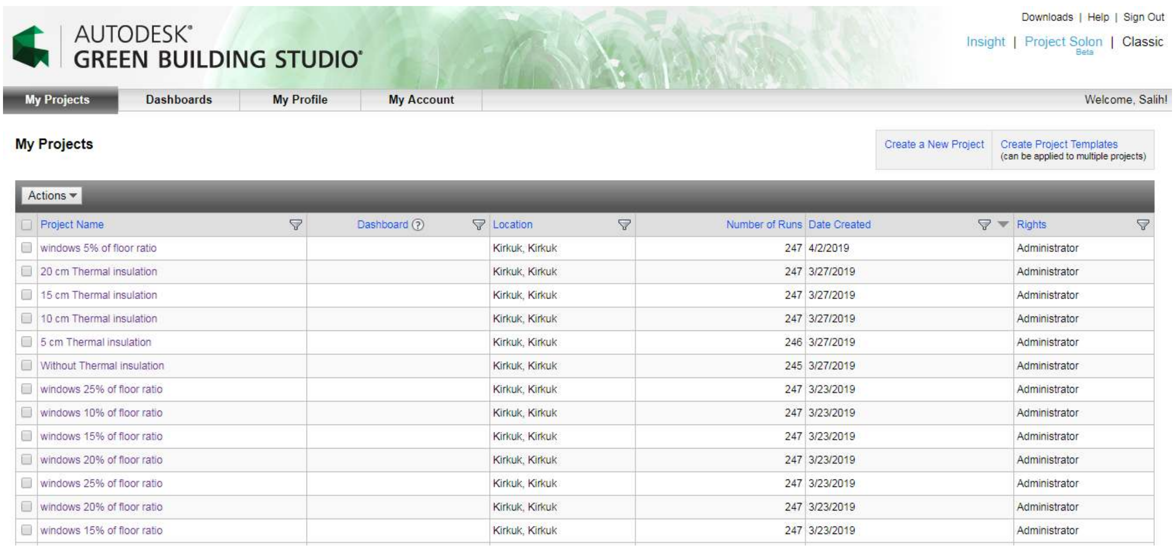


Figure 4.1. Profile in Green Building Studio.

ANSI/ASHRAE 140 is the standard method of testing for the evaluation of the building energy analysis computer programs. The purpose of the standard is to perform a comparative test of the energy analysis software over a broad range of parametric interactions and output types.

Figure 4.2. Charts for heat, cooling, and lighting in Green Building Studio

4.1.3. Hourly Analysis Program (HAP)

The Hourly Analysis Program (HAP) is a computer tool that helps engineers design HVAC systems for buildings. HAP are two tools in one. First, it is a tool for estimating loads and designing systems. Second, it is a tool to simulate energy use in buildings and calculate energy costs. In this capacity, it is useful for LEED, schematic design and detailed energy cost assessment. HAP uses the ASHRAE transfer method for load calculations and detailed simulation techniques of 8760 hours per hour for energy analysis.

HAP estimates the design of cooling and heating loads for school buildings in order to determine the required sizes of HVAC system components. Finally, the program provides the necessary information for the selection and identification of equipment. Specifically, the program performs the following tasks:

- Calculates the design of cooling and heating loads for areas, spaces and coils in the HVAC system.
- Specifies the airflow rates required for areas, zones and system.
- Cooling and heating coil sizes.
- Air circulation fan sizes.
- Chillers and boiler sizes.

4.1.4. Daylight Simulation Through Dialux Evo

Providing sufficient daylight and proper visual connection are two essential requirements for the llbeing and motivation of people living in buildings. The required lighting levels can be achieved with artificial light, daylight or a combination of both. Based on the calculation comparisons presented, Dialux Evo provides calculation results that are highly accurate and that this can bear comparison with standardized test procedures. The daylight calculations that occurred in DIALUX Evo used the latitude and longitude of the location and three different sky models, namely overcast sky, average sky and clear sky as in Figures (4.3-4.6). Daylight in DIALux Evo automatically creates an appropriate light scene when the designers calculate daylight in the building. After creating the simulation, the results are shown as contour lines with grades. Each zone between the lines differs from the other with different colors showing the appearance of the level of sunlight inside the rooms through the windows. The daylight calculation occurs only indoors and only through daylight relevant windows. There is an ongoing evolution in the design and planning of lighting systems where there is a shift in the view of the rooms, floors, buildings and external scenes as individual elements related to their overall presentation within the optical interaction [48].

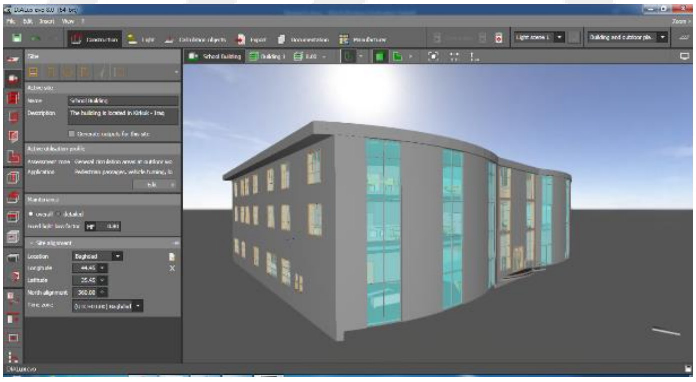


Figure 4.3. Position the location of building from longitude and latitude.

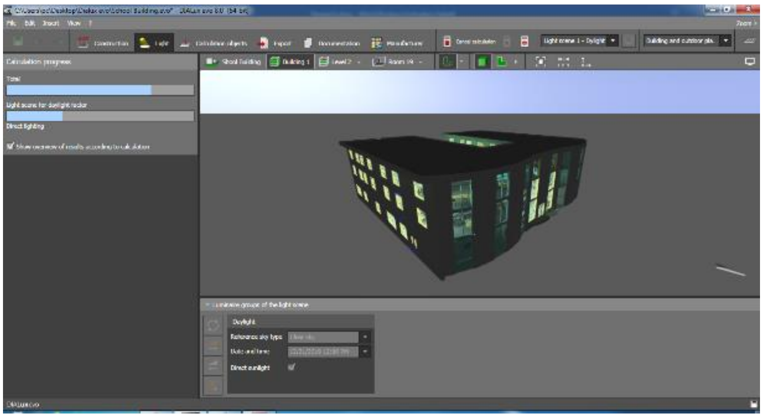


Figure 4.4. The process of simulation.

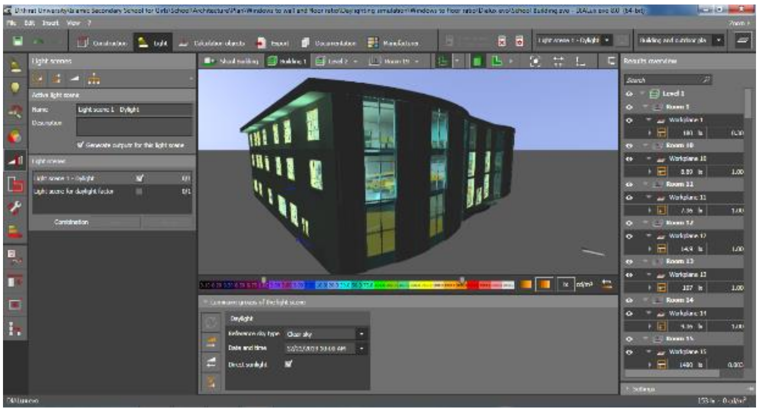


Figure 4.5. The simulation is complete.

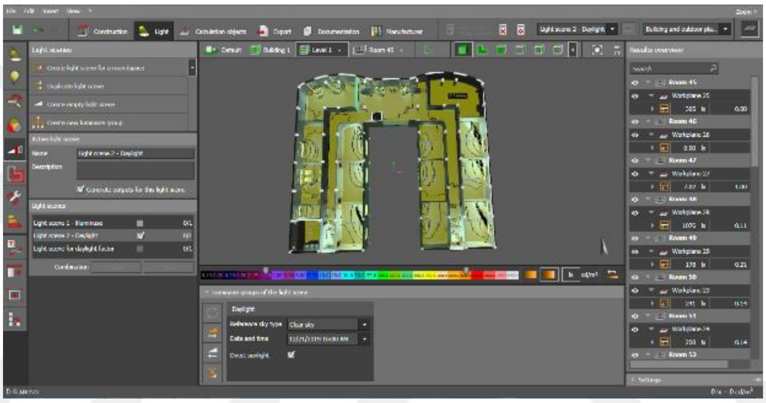


Figure 4.6. The interior design of daylight.

4.1.5. PV*SOL Software

The PV*SOL simulation tool provides excellent support for the evaluation and design of photovoltaic systems. The proposed system was simulated using the PV*SOL software for optimization. PV*SOL is a simulator that allows for the evaluation of the performance of the proposed hybrid power system [33]. The software provides many possibilities that offer an accurate assessment of the energy yield and any related important data. The effect of ambient temperature, humidity and the shading factors on the performance of the PV system are calculated in detail by this software. PV*SOL features integrated photography of all of the photovoltaic systems, whether they are installed on the surface, ground or even in the windows. The orientation and tilt of the photovoltaic panels can be optimally determined by this software. The total area required for the deployment of photovoltaic panels is calculated by taking into account the periodic maintenance and preventing the effect of shadows. PV*SOL has a large database including climate data, solar radiation details and it also provides for the perfect selection of solar system components through the most popular solar energy companies. By using this software, aimed to see the advantages of a PV installation that can be applied to the sample school buildings' envelope.

4.2. Assumptions and Limitations

The study aimed to constitute an SBM for the school buildings located in Kirkuk, Iraq where there are no regulations for educational buildings concerning providing comfortable indoor conditions for children in order to improve the performance of learning facilities. For this purpose, first the school building form is taken into consideration. The energy performances of differently planned school buildings re compared in terms of the heating and cooling energy requirements. Among the alternatives, one of them was selected according to the comfort requirements. In order to enhance the comfort conditions of the selected model, different cases according to different dimensions, orientations and window areas were constituted. The assumptions and limitations considered in the simulations performed within the study can be summarized as follows.

4.2.1. The climatic and Geographical Properties of Kirkuk City

Kirkuk is one of the hottest cities in the world. The temperatures may exceed 49 degrees celsius mid-summer. The monthly change in temperature at the meteorological station shows that for the period from (2012-2018), it is clear that the value of the temperatures in the city of Kirkuk was the highest in July and August. The lost quantity was in January and December. This is as in Figure (4.7). The measurements of the meteorological records show that the temperature of the city of Kirkuk for the year (2017) had a significant variation in temperature between night and day and between summer and winter. The average temperature for the whole year was (24.44 °C), where the lost value in temperature was (-1.7 °C) in February and the maximum value was in August (49.3°C).

The monthly change in direct solar radiation at the Accuather station shows that in the period from (2012 - 2018), Kirkuk city solar radiation reached the highest amount in July and the lost amount in December.

The direction of the wind is according to the geographical direction from which it is blowing to, but the prevailing wind direction is the most common trend. The monthly change of wind in the Kirkuk meteorological station shows in the period from (2012-2018) where it is clear that for the wind speed, the highest quantity is in April and the lost quantity was in November and December. In 2017, the average annual rate of wind speed is (0.59) m/s. The average wind speed varies slightly, being generally low for January and February with a monthly average of 0.38 m/s. From March to August, it is above 0.75 m/s and then the value drops from September to December with a monthly average of 0.47 m/s. Green Building Studio showing that the sample diagram of wind rose as in Figure (4.8).

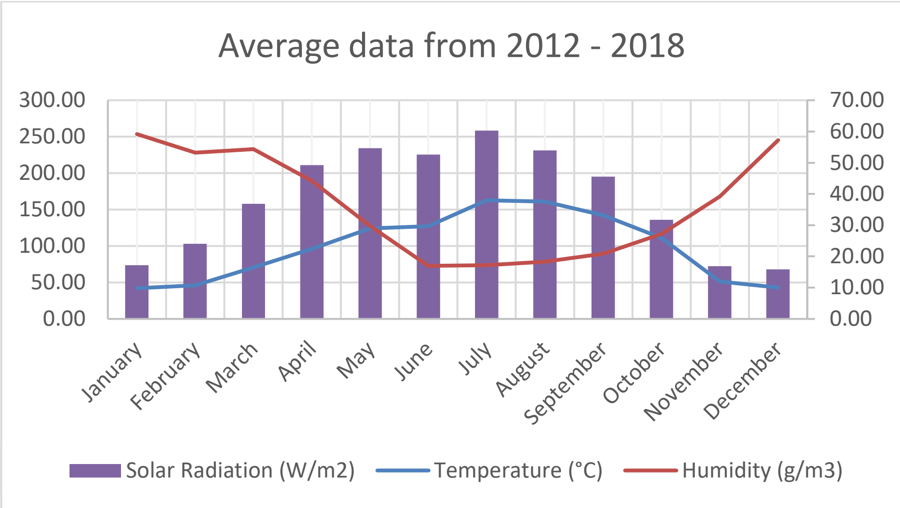


Figure 4.7. Kirkuk average climate data between 2012-2018.

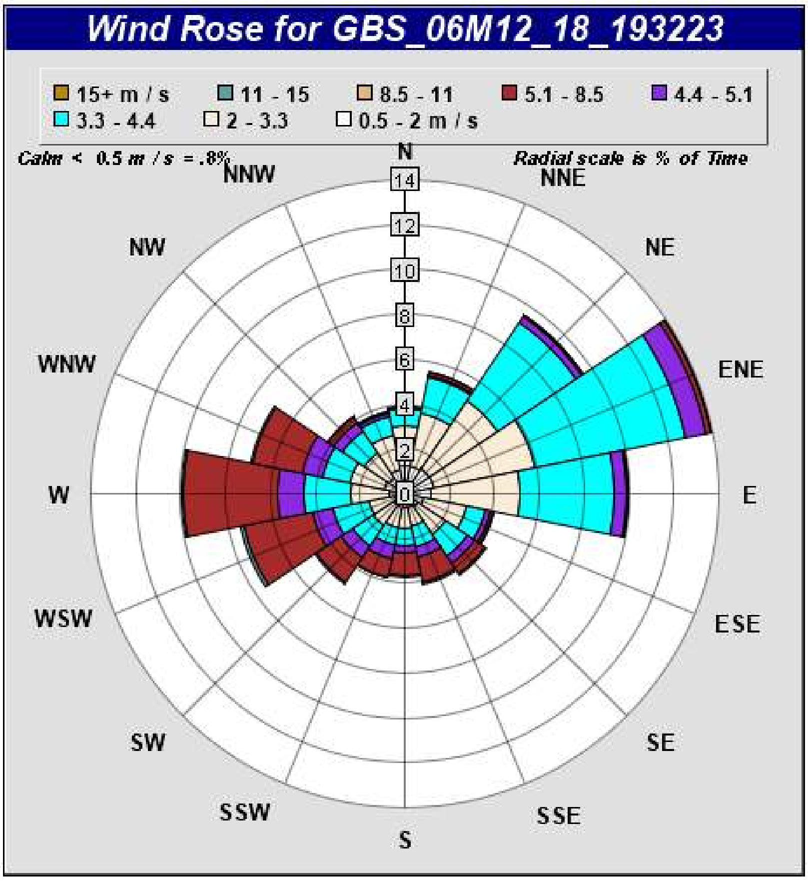


Figure 4.8. The wind rose for Green Building Studio (GBS).

The location of the building and climate characteristics of the site affect production and the amount of energy used in the building. The target of this study is to create the simulation of energy for the school building located in Kirkuk – Iraq which is 238 kilometers north of Baghdad. It is necessary to know the nature of the cities' climatic and environmental conditions so as to be able to develop requirements in accordance with the climate and environment. The site of the building is located at latitude 35°.45″ and longitude 44°.45″ is given in Figure (4.7).

Figure 4.9. Location of building in Green Building Studio

4.2.2. Model Samples Used in the Evaluation of the Effect of Building Form

Architectural design has a significant influence on the need for cooling and heating, so it is necessary to improve the solution of the concept of energy already in the initial stage of building design [49]. Six different forms of the model are made in the same area and the height was used to compare the type of model in terms of energy efficiency. The different types of models (square, rectangle, T, L, U, H) are the shapes selected as an example of the scope of energy use in the building. The shapes included re the floor, walls, and roof without any openings in the building as in Table (4.1).

The thermal performance of the buildings is affected by the general shape and the spaces that make it up. The appropriate shape of the building is preferred by reducing the area of the external walls as much as possible against the side of the building.

Table 4.1. Different building forms and the wall areas of the building samples.

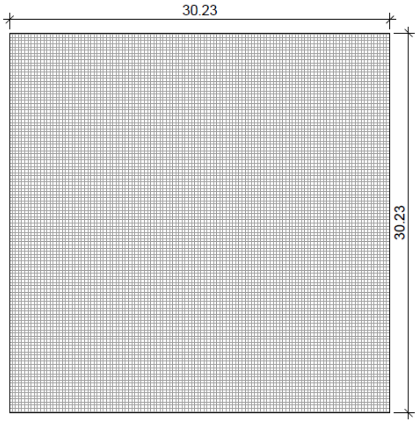
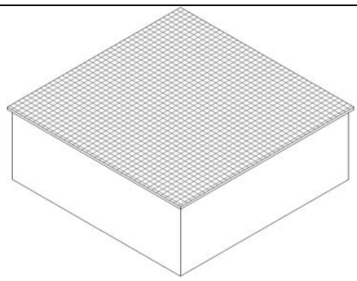
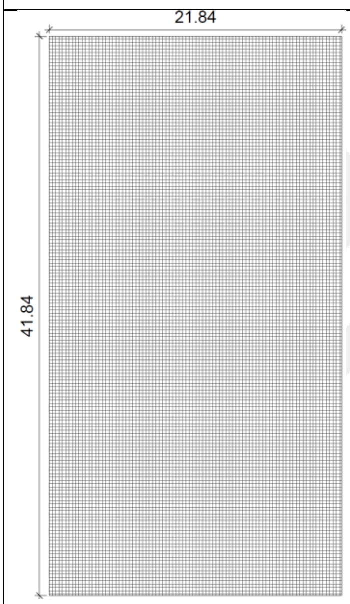
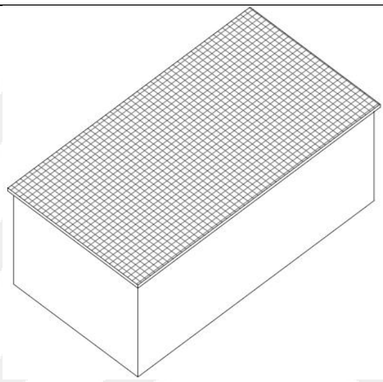
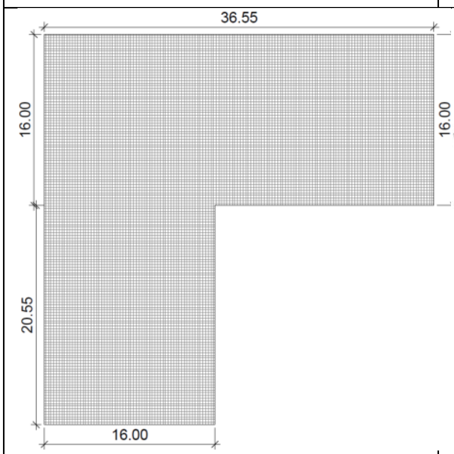
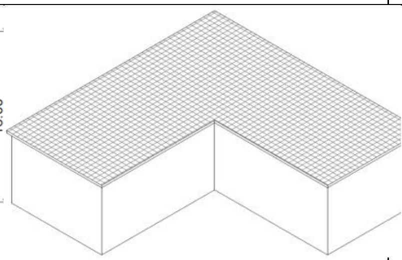
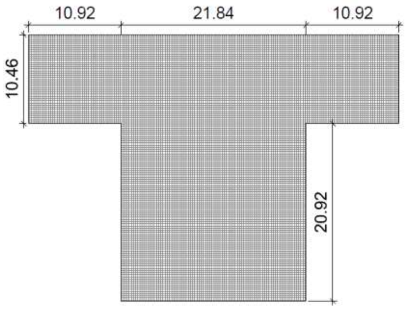
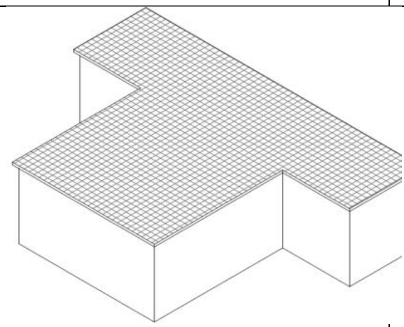
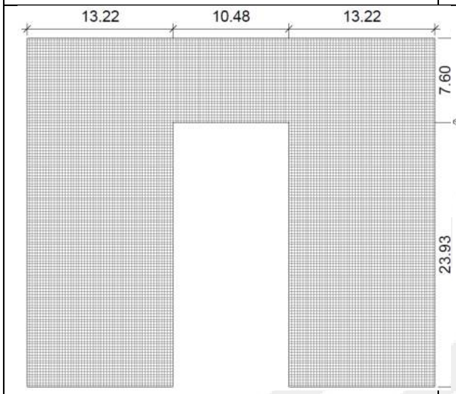
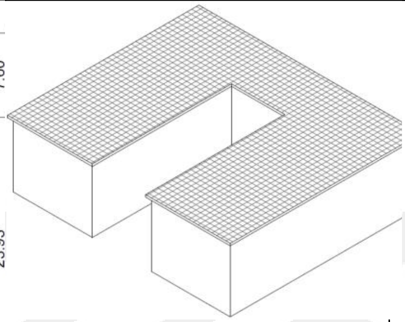
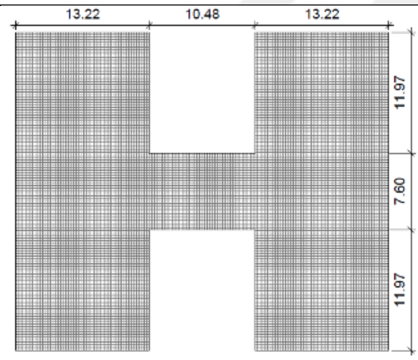
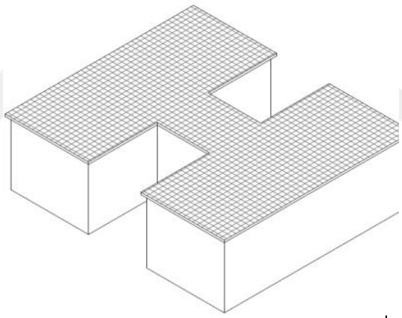
Plan (all dimentions in meter)	3D Model	Wall area (m^2)	Floor Area (m^2)
		1342	913.77
		1414	913.79
		1623	913.52

Table 4.1. (Continued)

Plan (all dimentions in meter)	3D Model	Wall area (m^2)	Floor Area (m^2)
		1666	913.79
		2050	913.43
		2051	913.43

4.3. Properties of the school sample for selected building form

The school building included three floors which were (ground, first and second). The Figure (4.10, 4.11, 4.12) plans of the floor were building height (11 m) and located on a plot (40 x 40) m^2 Figure (4.13, 4.14, 4.15). Each floor contained the names of the rooms with the area and the total floor spaces in Table (4.2) as follows:

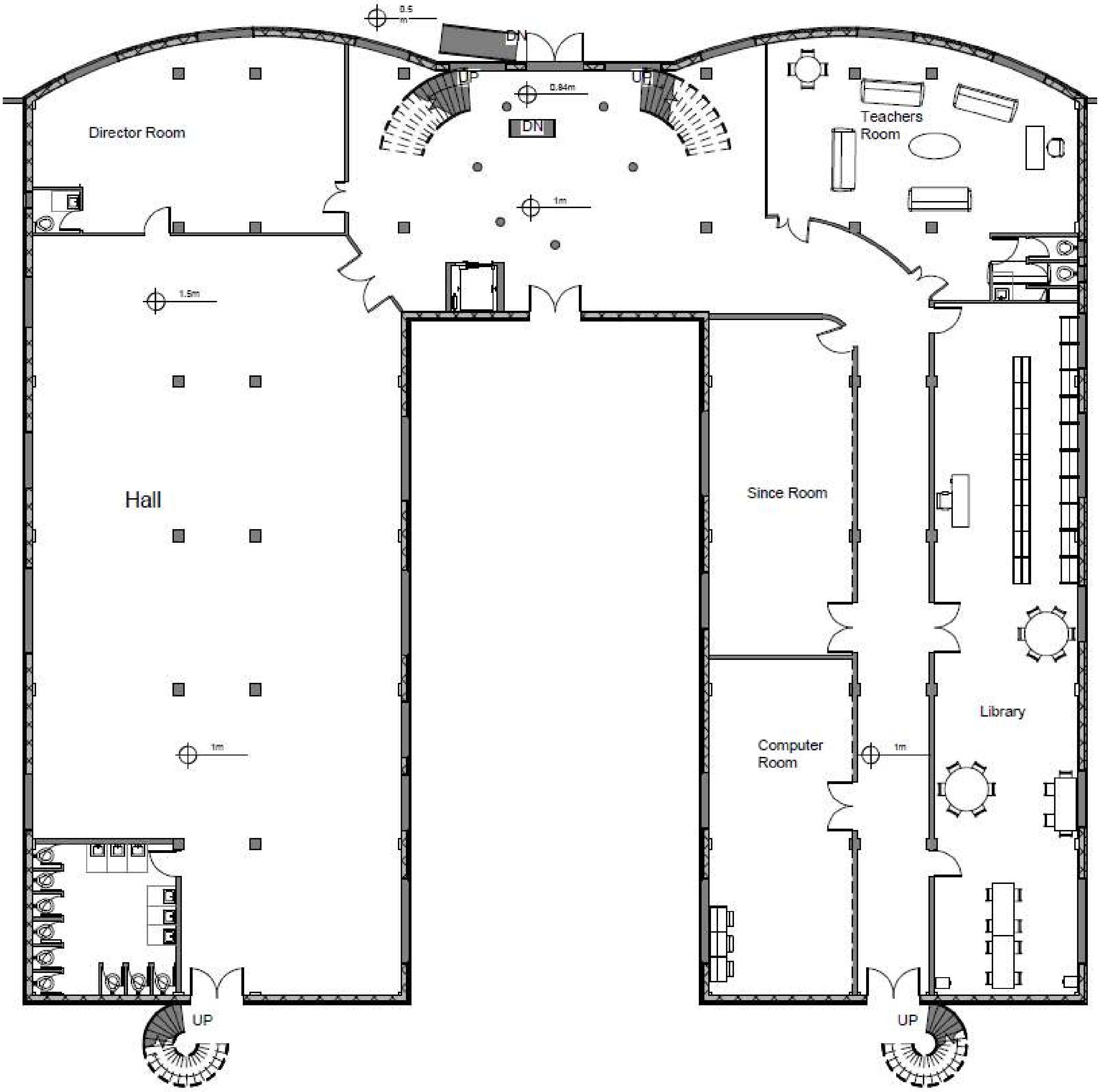


Figure 4.10. Ground floor.

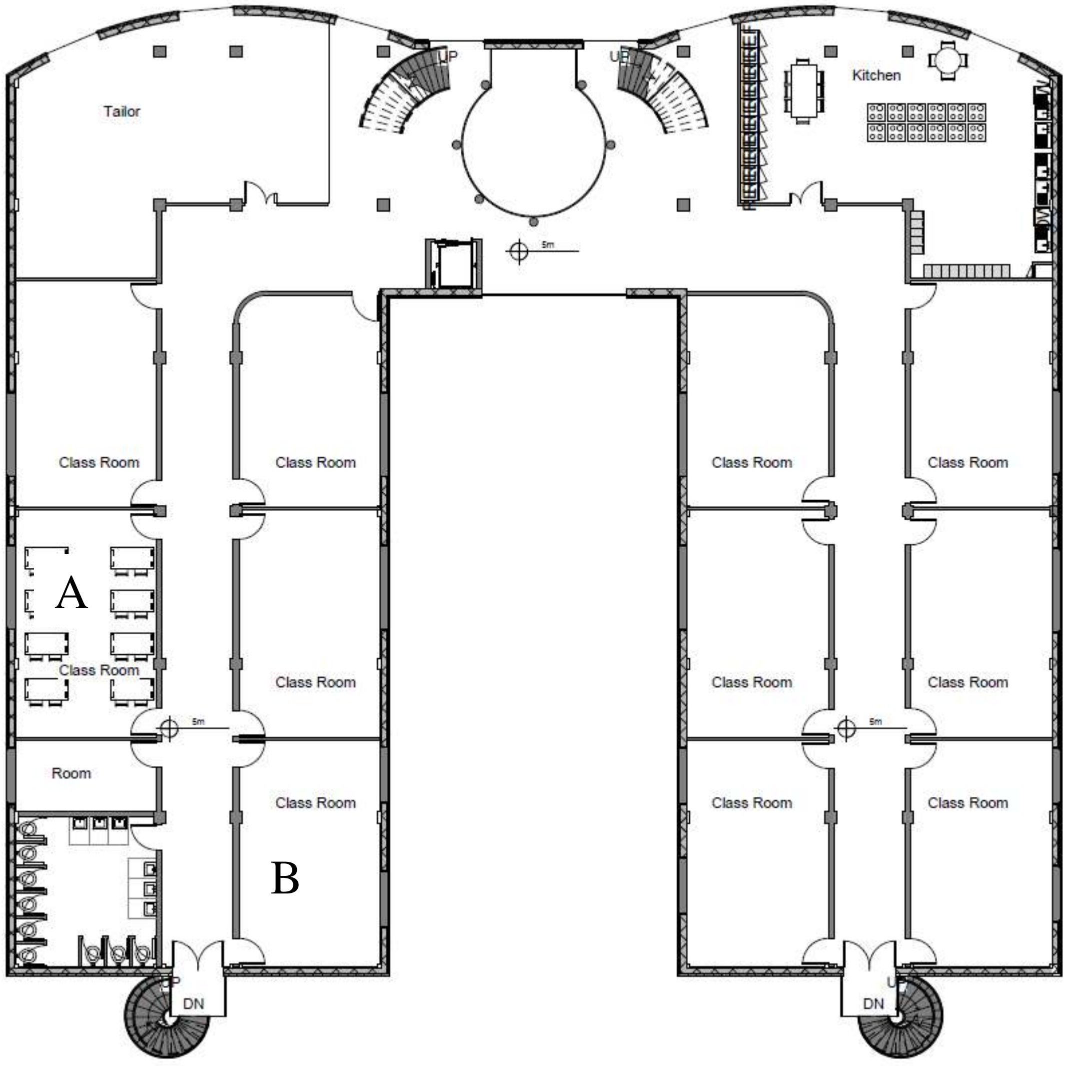


Figure 4.11. First floor.

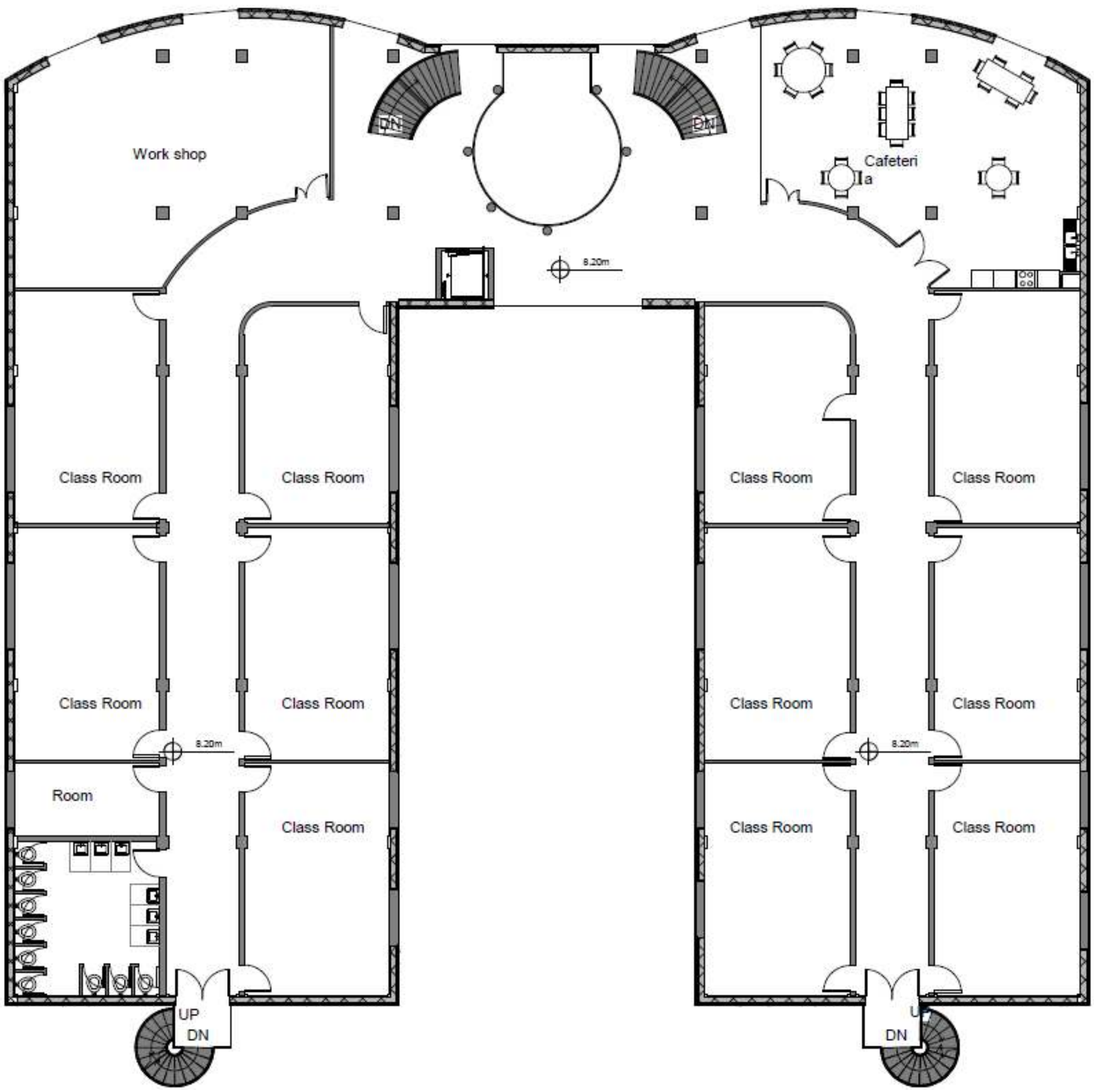


Figure 4.12. Second floor.

Table 4.2. Area of the ground, first and second floors.

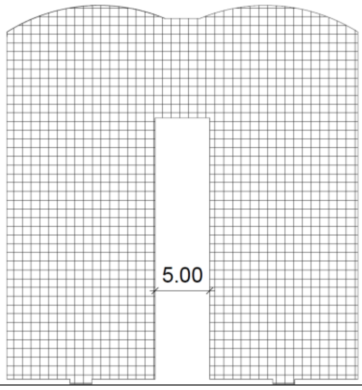
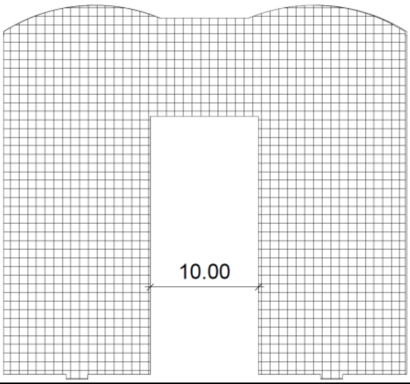
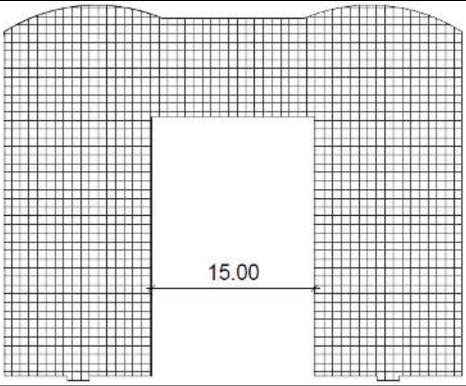
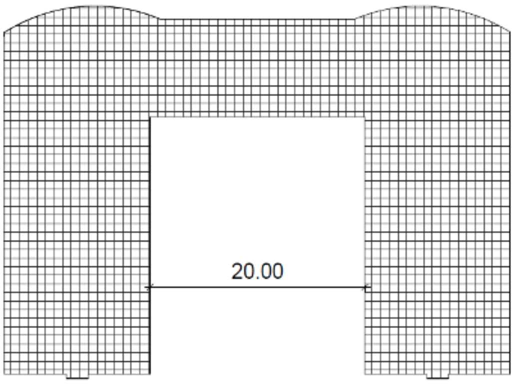
Room Name	**Number**	**Area (m^2)**	**Total area (m^2)**
Ground Floor			
Director Room	1	75	75
Teachers Room	1	84	84
Since Room	1	59	59
Computer Room	1	59	59
Library	1	121	121
Hall	1	340	313.5
Entrance	1	179	179
Baths	1	26.5	26.5
Total Floor Area			917
First Floor			
Kitchen	1	81	81
Tailor	1	81	81
Class Room	2	37	74
Class Room	9	40	360
Room	1	12.5	12.5
Entrance	1	278	278
Baths	1	26.5	26.5
Total Floor Area			913
Second Floor			
Cafeteria	1	81	81
Work Shop	1	81	81
Class Room	2	37	74
Class Room	9	40	360
Room	1	12.5	12.5
Entrance	1	278	278
Baths	1	26.5	26.5
Total Floor Area			913

Figure 4.13. Elevation.

Figure 4.14. Site plan.

Figure 4.15. Building a 3D model

Table 4.3. Different U-shaped building Scenarios

Different courtyard dimensions	Floor area (m^2)
	900.31
	942.50
	985
	1027.5

4.1.Different Courtyard Dimension Alternatives for the Sample Building

Heat energy, cooling, and lighting are used in buildings to provide the energy service of "comfort". This means providing space for heating in the winter and cooling in the summer, while also provide lighting in all seasons. It is important to build the building for the necessary functions that it will be used for, while using any additional spaces that lead to the need for more energy use in the building. In this title the U-shaped building model was constituted and different scenarios were considered with an increase of 5 m space in the courtyard as in Table (4.3). This was in addition to the analysis and simulation by the BIM model, indicating that a reduction the areas of the building lead to a reduction in the use of heating, cooling and lighting from the building.

4.2. Different Orientation Alternatives for the Sample Building

Orientation has an impact on the building's overall thermal performance when designing the heating, cooling, and lighting to reach the optimal level of occupant thermal comfort. The orientation of the building in a hot, dry climate is directed to the sun's considerations rather than wind considerations in order to ensure protection from the sun during the summer while allowing the guidance to reach the amount of sunlight required for the elements of the building during the winter to get some amount of solar heating. For the air movements, it is recommended that steering allows for air permeability in and around the building. The shape and orientation of the building block helps to achieve the minimum amount of heat possible in the summer and the greatest amount of heat in the winter. After the creation of the SBM through the Revit program, the location of the building was identified and then the building sample was oriented to the four cardinal directions (north, east, south and west) for only one courtyard dimension. In order to see the effect of orientation on the buildings' energy balance, simulations re carried out by employing the analysis tool for each orientation case as seen in Table (4.4).

4.3. Different Window Area Alternatives for the Sample Building

Creating a simulation for the heating and cooling is according to the window to wall ratio and also the window to floor ratio. The analysis of the four steps related to the area of the window in the building is based on the floor ratio, which improves the window and building envelope that applies in Table (4.5) since they are passive approaches to protect the demand for heating and cooling. They need more efficient equipment [50]. As a result, creating a simulation of the percentage of windows needed to improve the building envelope seems to contribute more to reducing and balancing the heating and cooling involved in the essential energy intensity as in Figure (7.11). The calculation of windows according to floor ratio is equal to each floor area of the building multiplied by percentage of ratio.

Table 4.4. The orientation of the building with windows area for every side

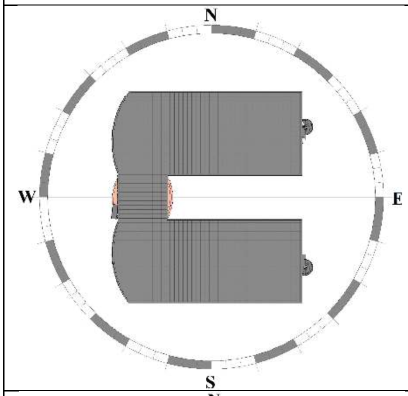
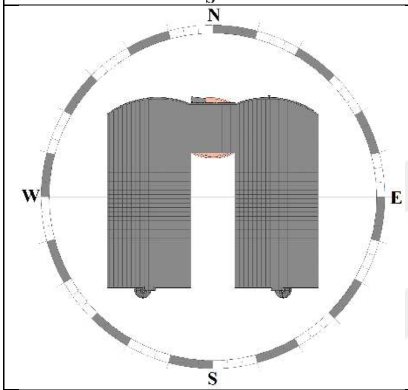
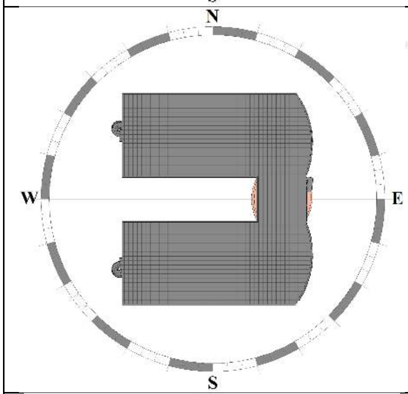
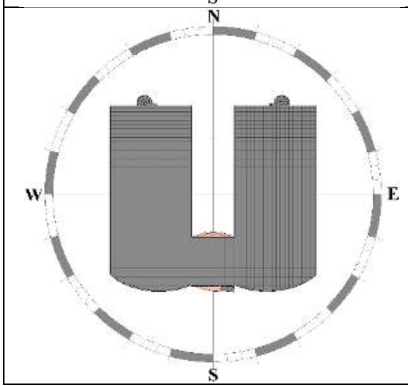
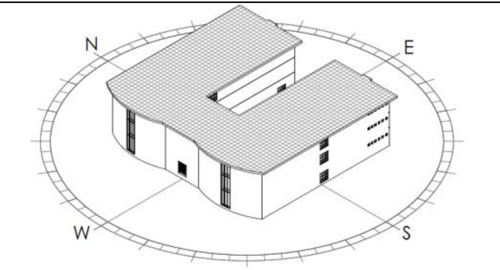
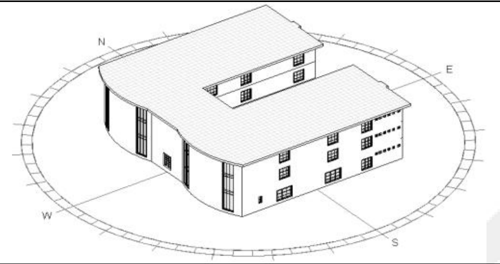
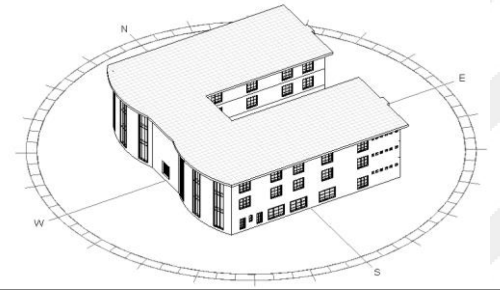
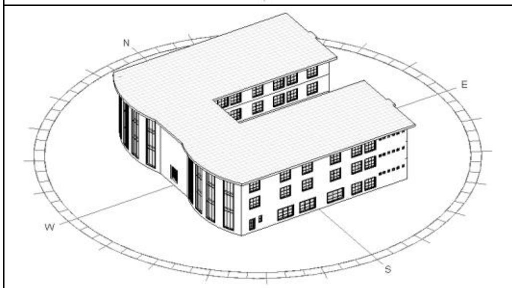
Directions	Window areas (m^2)			
	North	East	South	West
	206.22	88.57	191.96	161.80
	161.80	206.22	88.57	191.96
	191.96	161.80	206.22	88.57
	88.57	191.96	161.80	206.22

Table 4.5. The percentages and the areas of windows according to floor ratio.

Directions	Window/Floor Ratio (%)	Windows area (m^2)
	5	153
	10	283
	15	425
	20	570

4.3.1. Thermo-physical properties of the building components

The building envelope is the physical partition between the exterior and interior environments attached to the structure. In general, the building envelope consists of a series of components and systems that protect the interior space from environmental influences such as precipitation, wind, temperature, humidity and ultraviolet radiation. The study is focused on the effect of insulators in the walls, roofs, floors and windows on energy consumption in buildings in Iraq and quantifying the savings in the energy resulting from the application of insulators in buildings. The internal environment consists of the occupants, furnishings, building materials, lighting, machinery, equipment and the HVAC system. Appropriate details of the heat insulation should be adopted so then thermal bridges and other weaknesses are avoided. The Thermal Transition Requirements (U-value) for the maximum roof and floor values re included [51]. According to the Iraqi Thermal Insulation Codes [52] which relied on the Syrian Thermal Insulation Codes Table (4.6), the roof is (0.5 W/m^2K), the flooring adjacent to the soil is (1 W/m^2K) and the flooring between two floors, each with a separate energy source, is (1 W/m^2K). With regards to the thermal transition requirements (U-value), there has not been any obligation standards on the requirements and principles of the school building design related to energy-saving. The School Buildings Department Office in Kirkuk does not have any rules about thermal insulation. The engineers working in the office did not have any knowledge about the standards for energy-saving in the school buildings. Furthermore, there has not been any school buildings in Kirkuk built according to the thermal insulation code up until now.

Table 4.6. Maximum values allowed for the total coefficient of heat transfer of different building elements.

Structural element	**symbol**	**Maximum allowable values for heat transfer coefficient W/(m²K)**
Roof	U_{roof}	0.5
Exterior walls without openings	U_w	0.8
When openings are: $A_{win} \leq 0.2\ A_{facade}$	U_{win}	5.2
When openings are: $A_{win} > 0.2\ A_{facade}$	U_{win}	3.5
External facades include all openings	U_{facade}	1.5
Flooring adjacent to soil	U_G	1
Floors between two floor	U_F	1
Flooring exposed	U_F	0.5

The good thermal design of the buildings plays a major role in reducing the thermal loads of the heating and cooling systems, thus reducing the energy consumption, reducing the cost of the systems and lowering the cost of installation and periodic maintenance.

It is important to improve the thermal insulation thickness to save energy and to reduce carbon emissions in Iraq's climate. Many standards and regulations on energy efficiency and thermal insulation focus on insulation thickness, taking into account that the cooling, heating, lighting, health care, life cycle or environmental effects are a part of energy efficiency [53]. This can lead to unexpected and undesirable results. A new method was applied to determine the insulation materials and their thickness on a SBM in the Kirkuk climate of Iraq with heat transfer coefficient Table 4.7.

Table 4.7. Heat transfer coefficient for SBM elements.

Structural element	**Heat transfer coefficient (U-values (W/m^2K)) for SBM**
Roof	0.18
Exterior walls without openings	0.18
Windows & Door Windows	3.13
Door faces the street	4.28
Door faces the courtyard	3.18
Flooring adjacent to soil	0.19
Floors between two floor	0.36

The method considers the energy consumption for the heating and cooling loads, creating a simulation of the school building envelope with different thicknesses of insulation between (5 - 20) cm as in Figure (4.16). The results of simulating the heating and cooling loads with different thicknesses of the insulation material in the building envelope are as shown in Figure (5.7).

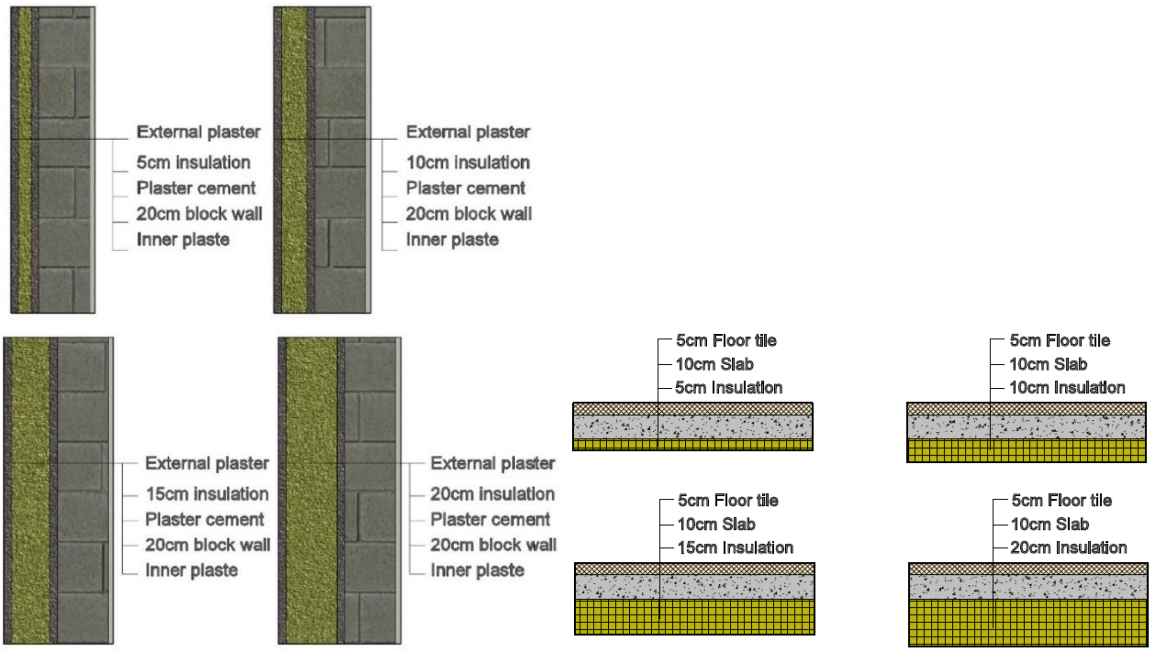


Figure 4.16. Thickness of thermal insulation for walls and floors in the building envelope.

4.4. PV system

Considering the high solar potential in Iraq, a significant amount of electricity generation is possible using the current PV technology. For this reason, a three-storey detached school building located in Kirkuk was used to calculate the electricity loads of the building as in Table (4.8). Creating the model for the U-shape of the school building was popular because reducing the heating, cooling and lighting loads lowered the consumption of the new and flexible designs of the economic units if compared with the traditional school design in Iraq. The solar system should be operated as efficiently as possible under standard operating conditions.

Table 4.8. Electricity consumption of the SBM model.

Items	**Floor no**	**Number**	**Power (W)**	**Load (W)**
Florence 4 x 20	3	164	80	39360
Florence 2 x 40	3	24	80	5760
Light 100w	3	24	100	7200
Sport light 40w	2	15	40	1200
Outlet socket	3	80	60	14400
Split	3	20	1500	90000
Fan	3	31	120	11160
Elevator	1	1	3000	3000
Water pump	1	2	500	1000
Total loads				173,080.00

The simulations were performed on grid-connected 168 kWh PV systems using PV*SOL Figure (4.17). The compatibility of the grid-connected PV system makes it an auxiliary and alternative source of energy. The grid connect system works in parallel with the traditional power source. The energy provided by the PV system is clean, free of harmful emissions and without a loss of transmission and distribution. As well as having no requirements for batteries, the system costs less and its maintenance needs are much lower than the stand-alone systems. The essence of this study was to compress the performance simulation of the solar system by taking into consideration the BIM technology. The performance of the photovoltaic system depends on the domestic weather, the orientation, the tilt of the PV array, the inverter performance and the efficiency of the PV modules.

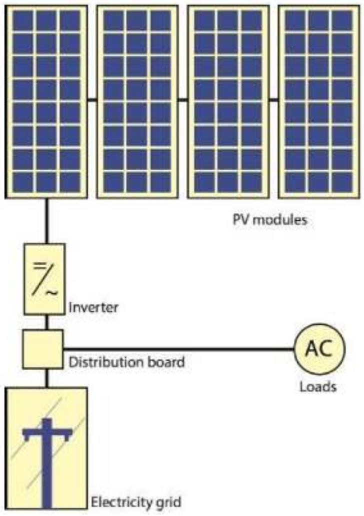


Figure 4.17. Schematic representation of a grid-connected PV system.

The system is constituted with 508 PV panels and the Salo Solar company production this panels, model name is (ss330P). Starting with radiation on the surface of the PV panels, the solar PV panels operating over the day will convert the sun's radiation into electrical energy. The panels produce DC electricity and this will be converted by the inverter into AC. The system contains four types of inverter (SGI 33K-02 home) by the manufacturer Schüco international (KG).

5. RESULTS AND DISCUSSION

According to multiple different cases, SBM's energy requirements, after they were simulated, revealed important parts of energy efficiency such as reducing the heating, cooling and lighting and the renewable energy use for the building. The results re obtained through the Revit, Dialux Evo and PVsol software.

5.1.Validation

The validity analysis of the simulation results of the heating-cooling, lighting energy requirements and photovoltaic system installations for the sample school building were performed. For this purpose, the heating and cooling energy requirements calculated with the Green Building Studio were compared with the results of the HAP Program. Dialux program was evaluated together with the results obtained from Revit. The energy outputs obtained from the PVsol program of the photovoltaic installation were also verified with the PVsyst software.

5.1.1. Revit with Green Building Studio & Hap for Heating and Cooling load

Create energy analytical model from the Revit analysis and Green Building Studio also convert model from Revit to Hap through gbXML file. Create simulation of SBM in both programs the results showing percentage of difference for heating and cooling load between results of two programs Table 5.1.

Table 5.1. The results of simulation for heating and cooling loads in Revit with Green Building Studio and Hap softwares.

Software	Heating (MJ)	Cooling (kWh)
Revit analysis and Green Building Studio	173162	55094
Hap	147960	53500
Percentage of difference	14 %	3 %

5.1.2. Revit & Dialux Evo

Through Autodesk 360 rendering create a daylight simulation of the interior SBM, the results showing all spaces in the building contain enough daylight except toilets and entrances. The results show that there is no daylight value in some toilets and entrances on the same spaces of red colors of (Figure 5.1). Furthermore, with Dialux evo, create simulations at the same time and on the same date as the Revit simulation shown in (Figure 5.2). The same low level of illuminations are obtained from Dialux software.

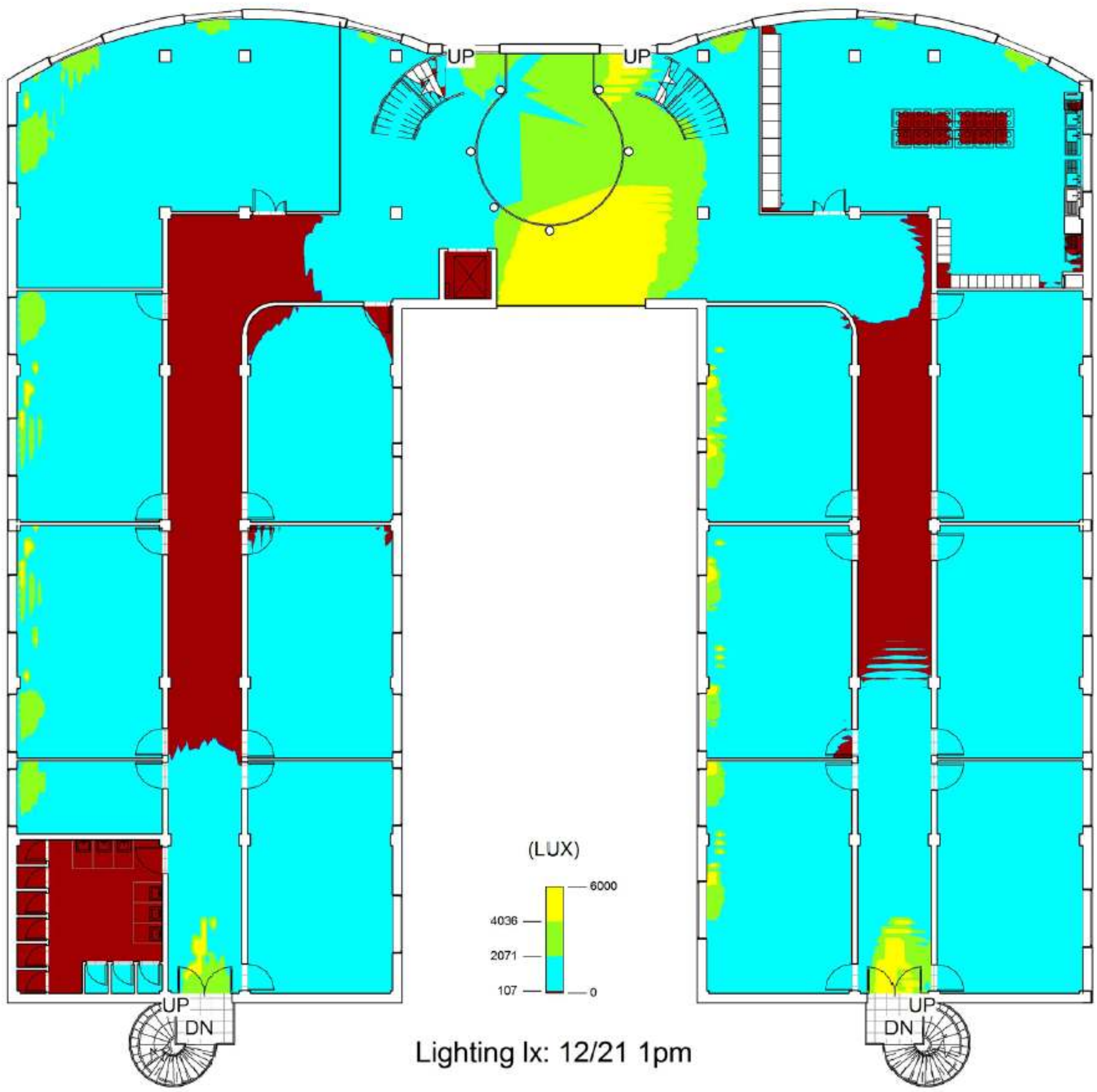


Figure 5.1. First floor daylighting at 1 pm on 21st. December by Autodisk 360.

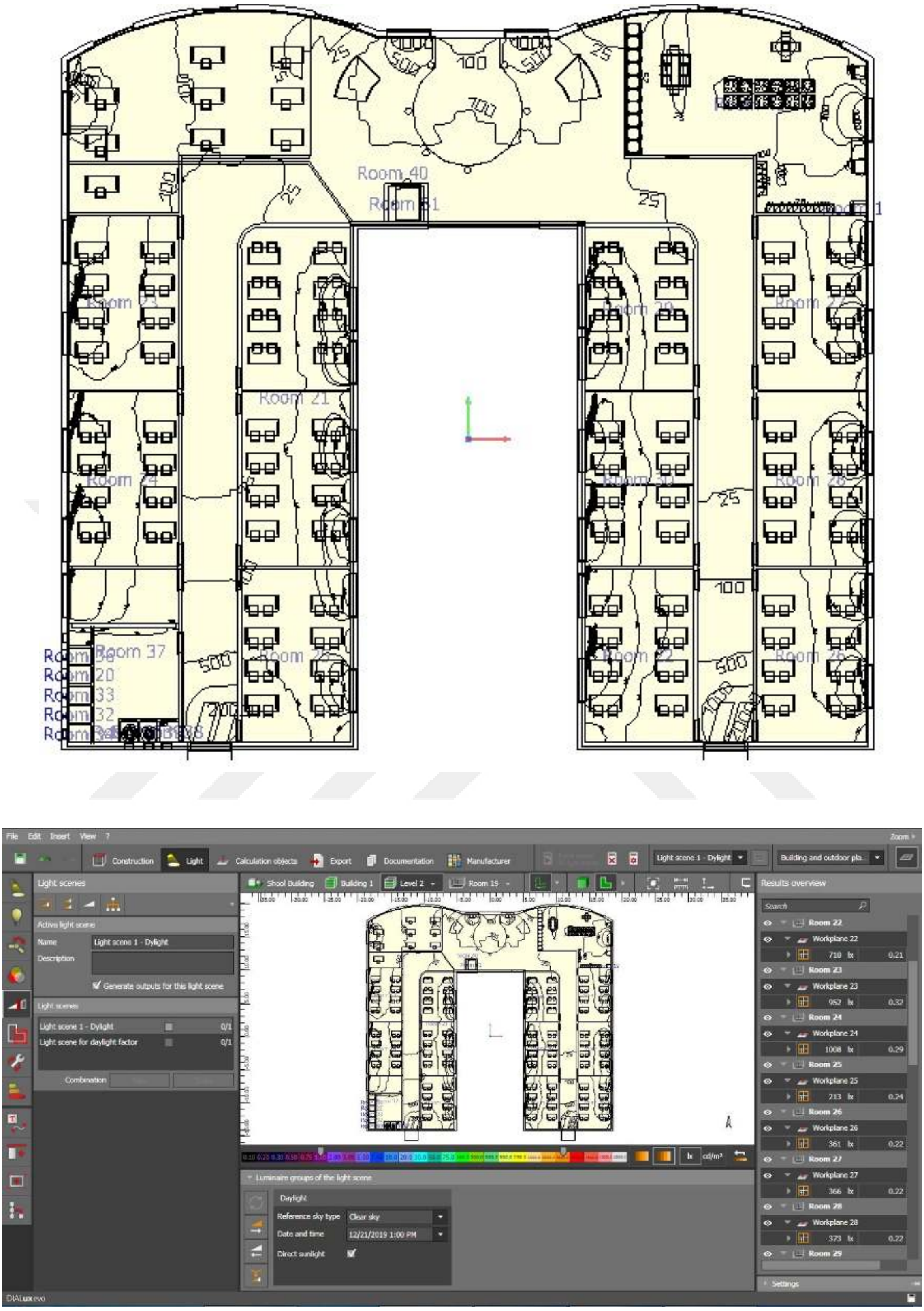


Figure 5.2. First floor daylighting at 1 pm on 21st. December by Dialus evo.

5.1.3. PV*SOL & PvSyst

In both programs they installed similar photovoltaic solar panels and similar inverters that use the grid-connect system in simulations that appear when the number of PV panels is 507 which gives 167 kW in PVsyst (Figure 5.3).

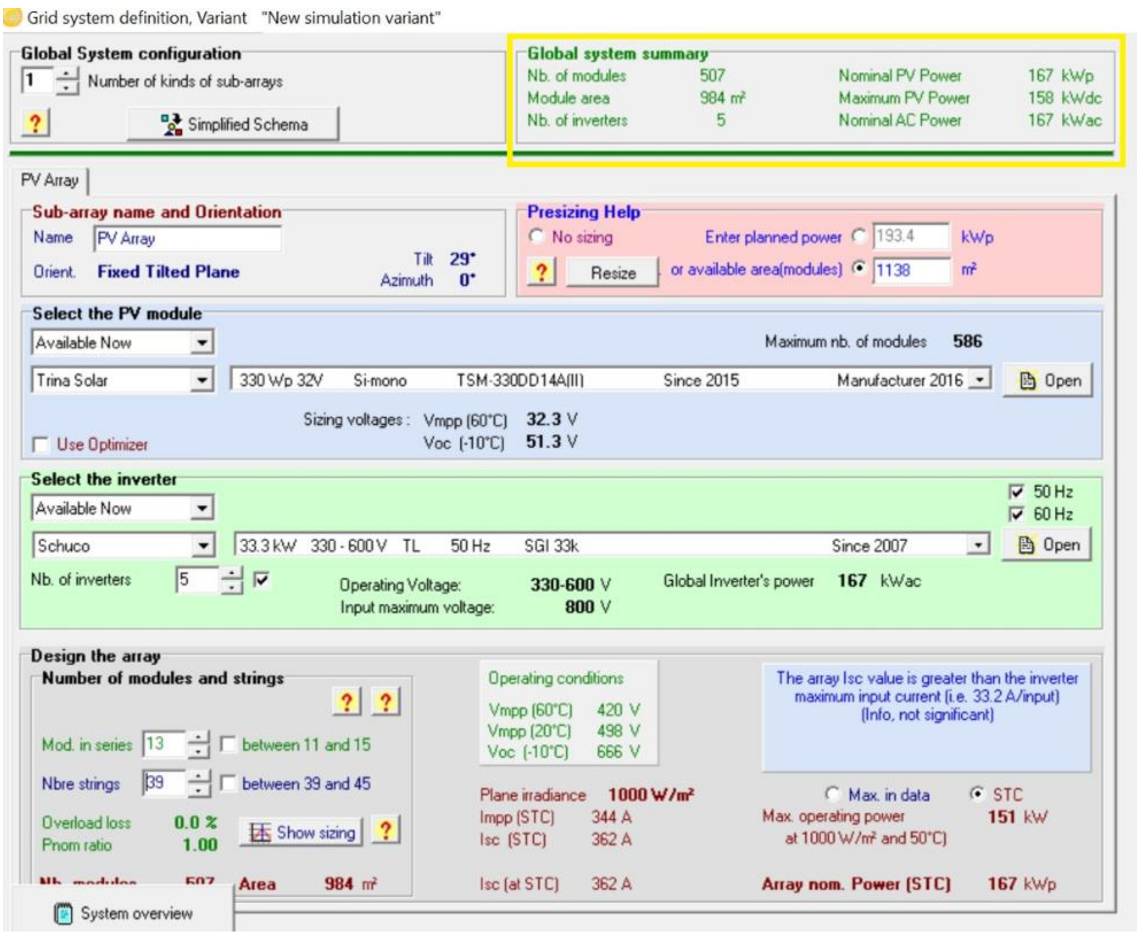


Figure 5.3. Result of tilt 29◦ Panels PV module in PVsyst.

Annual Energy output of the PV installaition is calculated both with PV*SOL and PvSyst softwares. When the results for the system assumed to be installed for 29 ° tilt angle are compared it is seen that the annual energy productions for PV*Sol and PVsyst are 258.9 kWh/year and 290.9 kWh/year respectively. The specific production of the systems are 1545 for PV*SOL and 1739 for PVsyst softwares. The difference between the results is approximately 12 % for annual yield and specific production. The main reason for this amount of error is thought to be the imcompatible system components in both softwares.

5.2. The Energy Requirements of the Buildings Having Different Forms

The different types of forms (square, rectangle, T, L, U, H) have the same area and the same height. The models and simulations were created by the Revit (BIM) software, and through Autodesk Green Building Studio, obtained the results of every month throughout the year according to the charts. The results show a reduction in energy consumption when there was a minimization of the external wall element in the building as in Figure (5.4, 5.5).

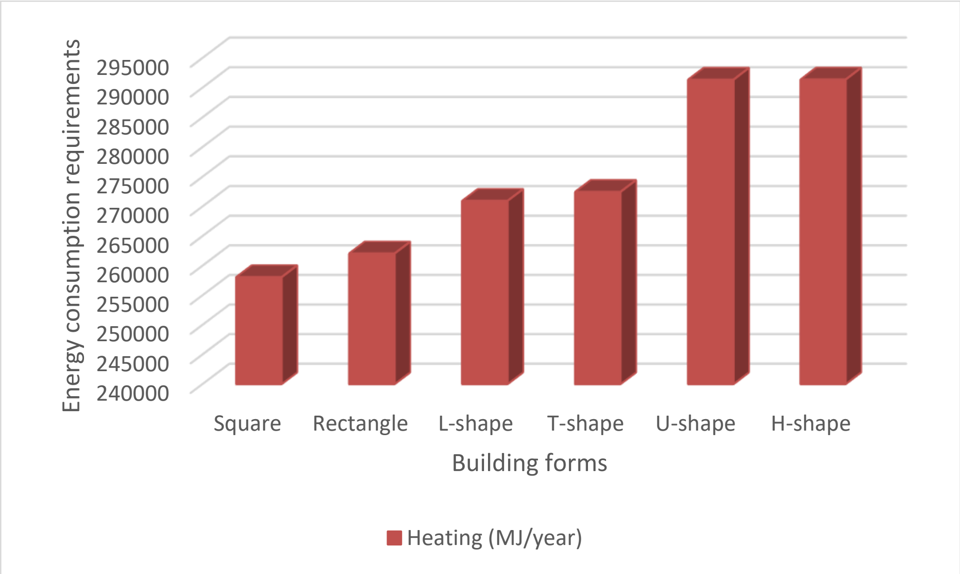


Figure 5.4. Results of heating for different forms of the (SBM).

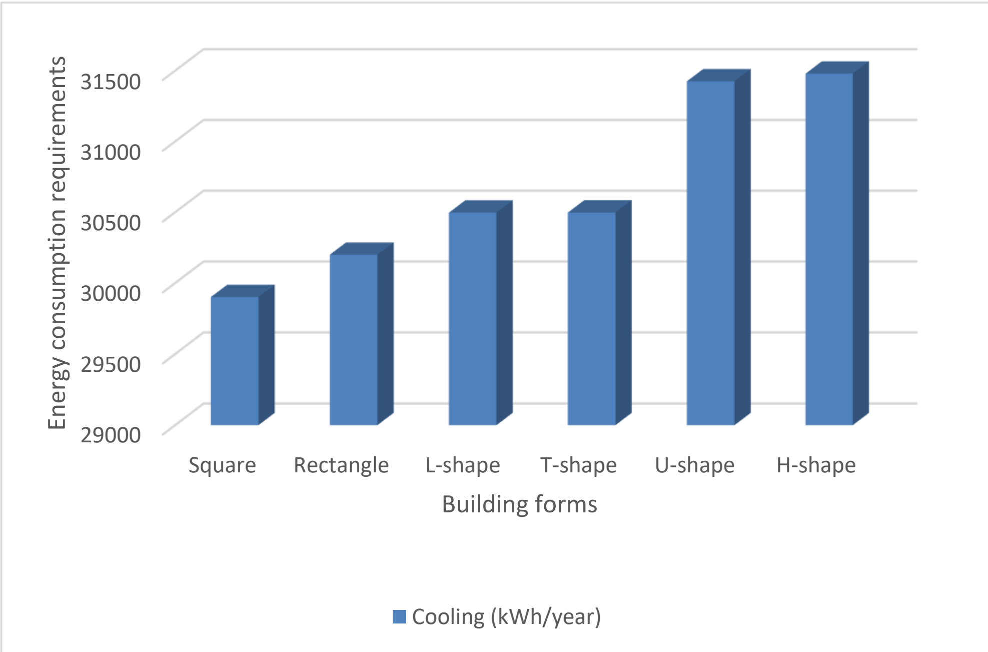


Figure 5.5. Results of cooling for different forms of the (SBM).

The rectangular building has more of an energy demand than the square building by a percentage (1.55 %) and the L-shaped building requires more of a demand in energy than the rectangle building with a percentage (3.40 %) in the same floor area. This is where the energy requirements have increased to (6.93 %) between the T and U-shaped building. The graphs and the percentage of results showed that increasing the area of the external walls in the building leads to an increased use of energy in the building.

5.3.The Results of the Different Courtyard Alternatives of the Sample Building

The results of this topic indicate that it does not seek to enlarge areas of the building without justification. It also sought to determine if it is possible to try to reduce the area of the building because of the exposure to solar radiation and to reduce the loads of the heating, cooling and lighting. An increased building area leads to an increase in the energy requirements of the building as in Figures (5.6-5.8). The courtyard width increases from 5m to 20 m with 5m steps shows that the heating energy requirement of the building sample increases by 7.22 %, 4.56 % and 5.92 % respectively. The cooling energy requirement of the building sample increases by 1.55 %, 1.62 % and 3.23 % and the lighting requirements of the sample building also increase in 5m steps as per the increase in floor area. The optimal dimension of the courtyard is determined as 10 meters because the school building receive enough daylight on this dimension. The greater the surface area and thus there is an increase in the area exposed to heat exchange on the one hand and on the exchange of solar radiation on the other hand. Increasing the size of the internal space of the building was done by increasing the requirements of the energy for cooling in the summer, heating in the winter and lighting in all seasons.

5.4.The Results of the Different Orientation Alternatives of the Sample Building

Window space on all sides of the building is an important factor affecting the building orientation, showing the direction of the building and the window area for each side. After the simulation was created for each direction of (SBM), the results in Figure (5.9) show that the heating and cooling loads in the northern direction were less loaded, as was the lighting in the southern direction.

Most of the windows are located to the north where good solar access is the easiest to manage, with minimal amounts of window area in the east and west facades. The windows in the south can help to promote good ventilation but they may be the source of the heat loss.

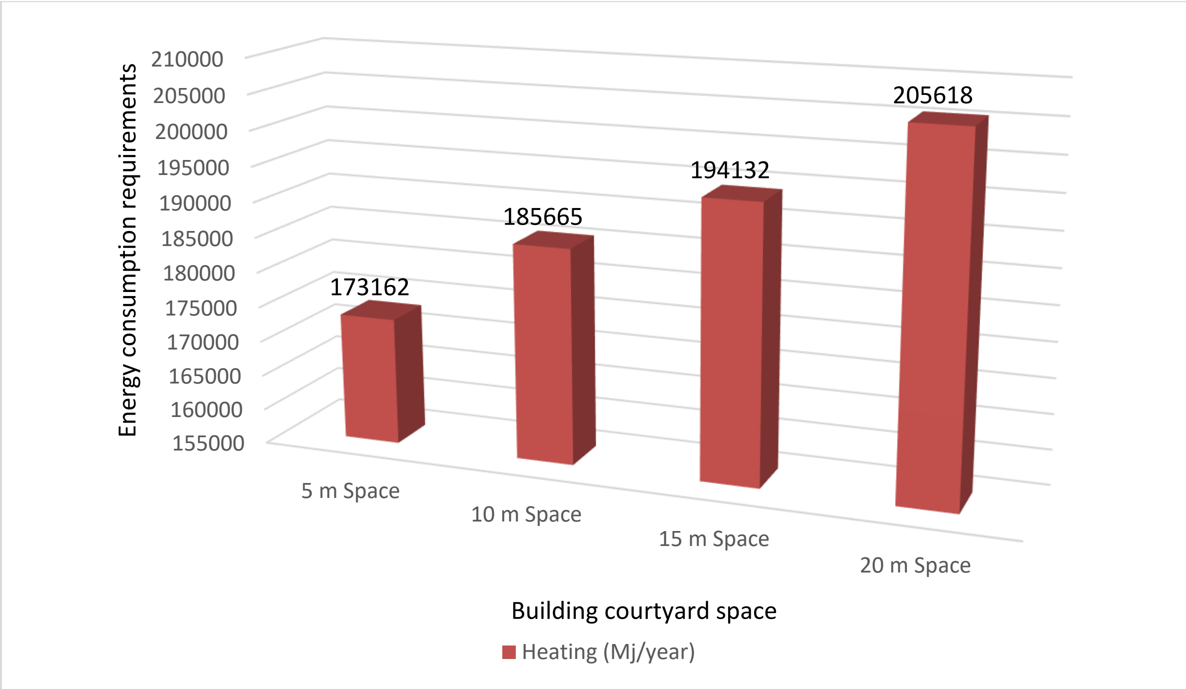


Figure 5.6. Increase building areas in four steps for heating load results.

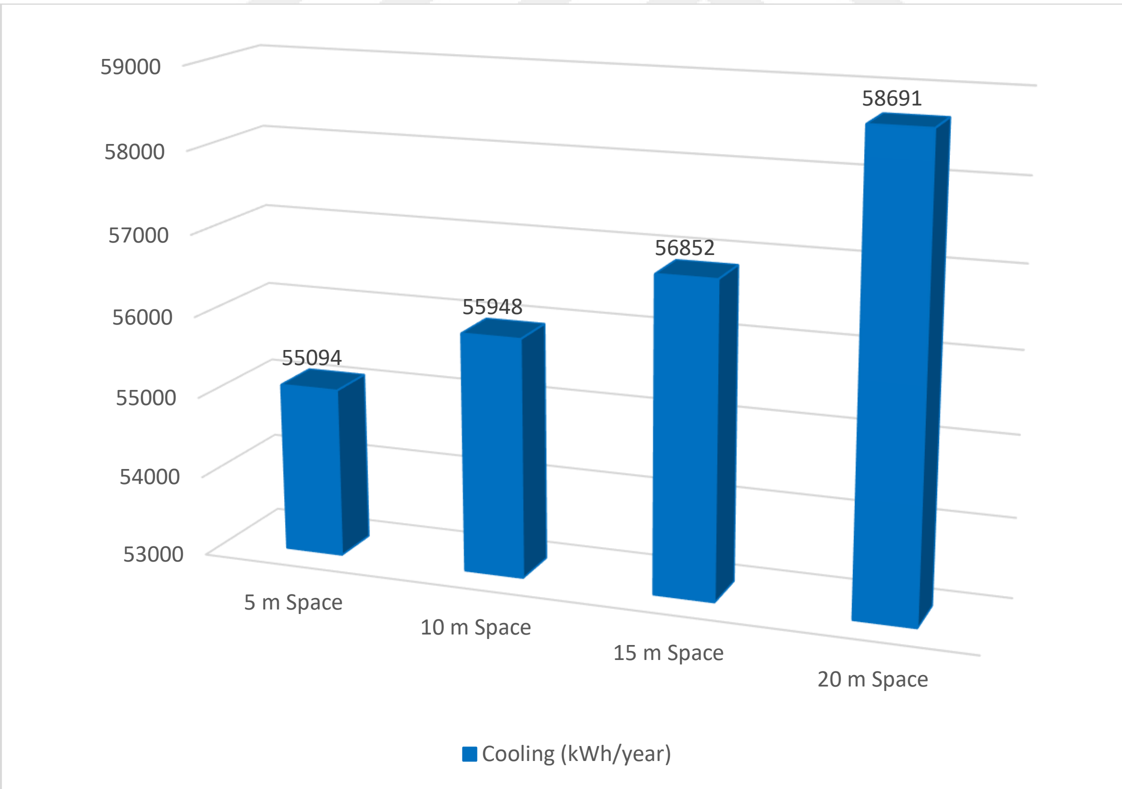


Figure 5.7. Increase building areas in four steps for cooling load results.

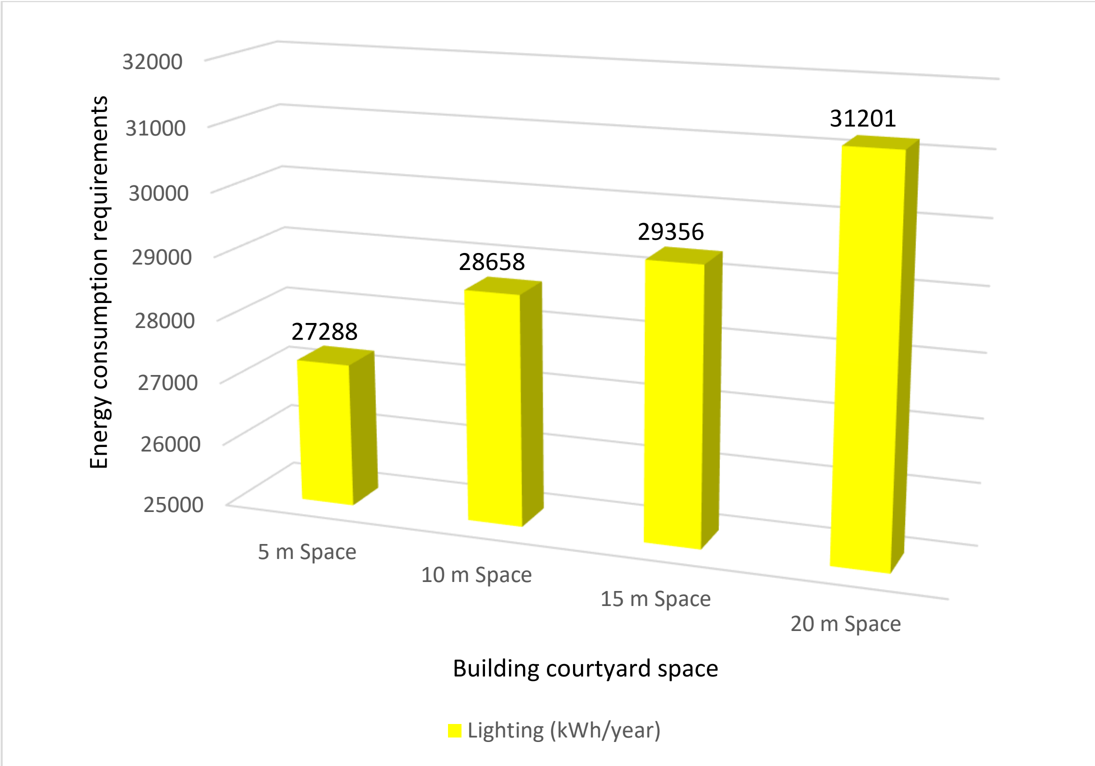


Figure 5.8. Increase building areas in four steps for lighting load results.

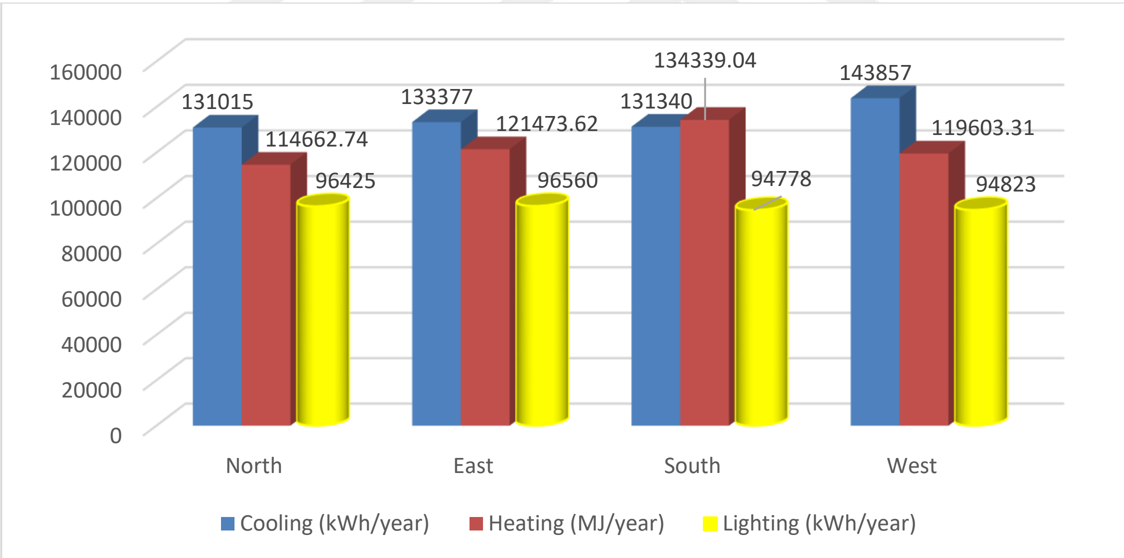


Figure 5.9. (SBM) orientation results for heating and cooling consumed in a year.

5.4.1. Thermo-physical properties of the building components

The results of the insulation applications assumed to be applied on the SBM were compared. The results showed that the building without insulation consumed a lot of energy. It will reduce the energy used when increasing the thickness of the insulation installed as in Figure (5.10). The cooling and heating energy requirement of the building sample decreased in percentages of 3.5 %, 2.44 %, 0.20 % and 0.03 % respectively for increases of 5 cm insulation in 5 steps from (0 - 20) cm insulation for the building envelope. The highest difference between insulated applications and non-insulated building model was achieved in the application where the thermal insulation was 5 cm.

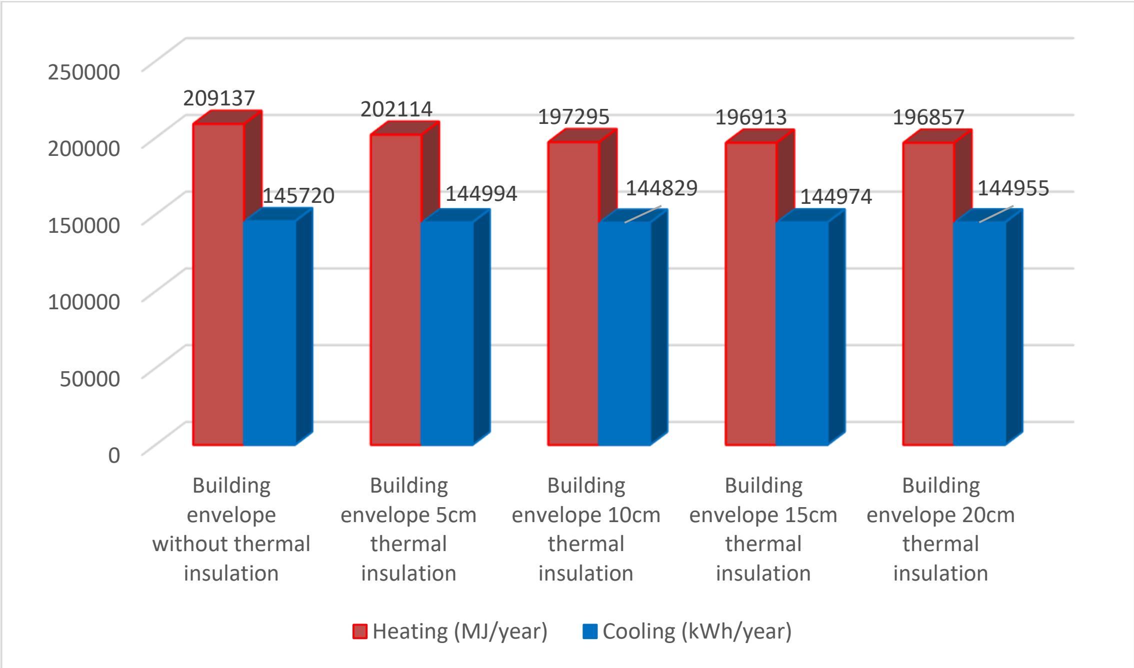


Figure 5.10. Result of heating and cooling at different thickness of insulation in the building envelope

5.4.2. Daylighting

Revit is a built-in analysis tool for the internal environment where an energy simulation can be performed by creating a model. This makes it possible to work out an analytical model in Insight 360 in order to get a better understanding of the lighting analysis performed in Revit. In this study, this was conducted on the possibilities related to the interior design of daylight in the building, as in Figure (5.11, 5.12, 5.13, 5.14). In addition, according to simulation of the internal side, it showed a blue color in almost the entire school building model (SBM). This means that natural light is clearly visible in the school classrooms. The entire interior building has sufficient natural light during of time (10 Am - 1:00 Pm) except for the entrances and toilets.

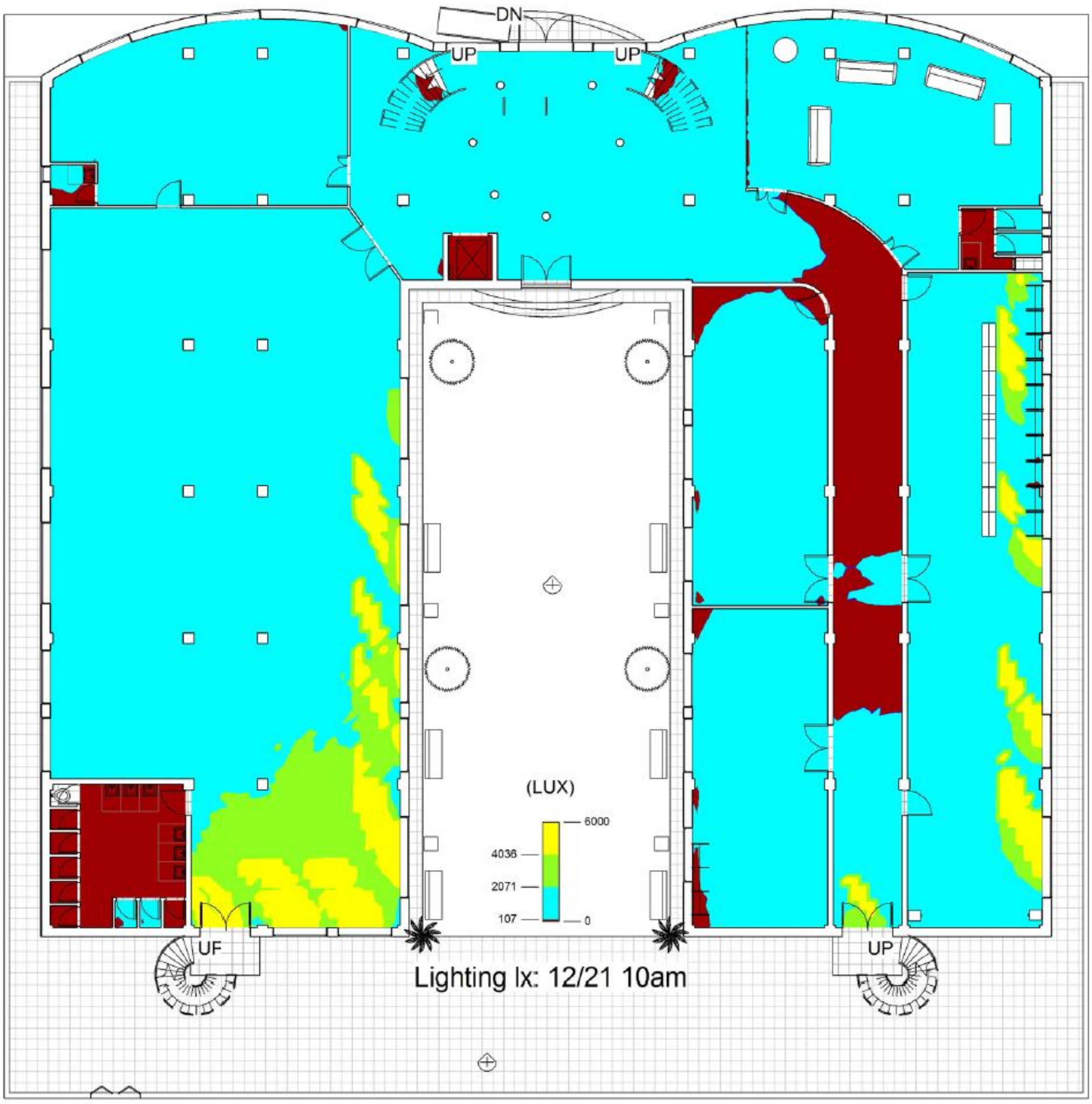


Figure 5.11. Ground daylighting at 10 am on 21st. December.

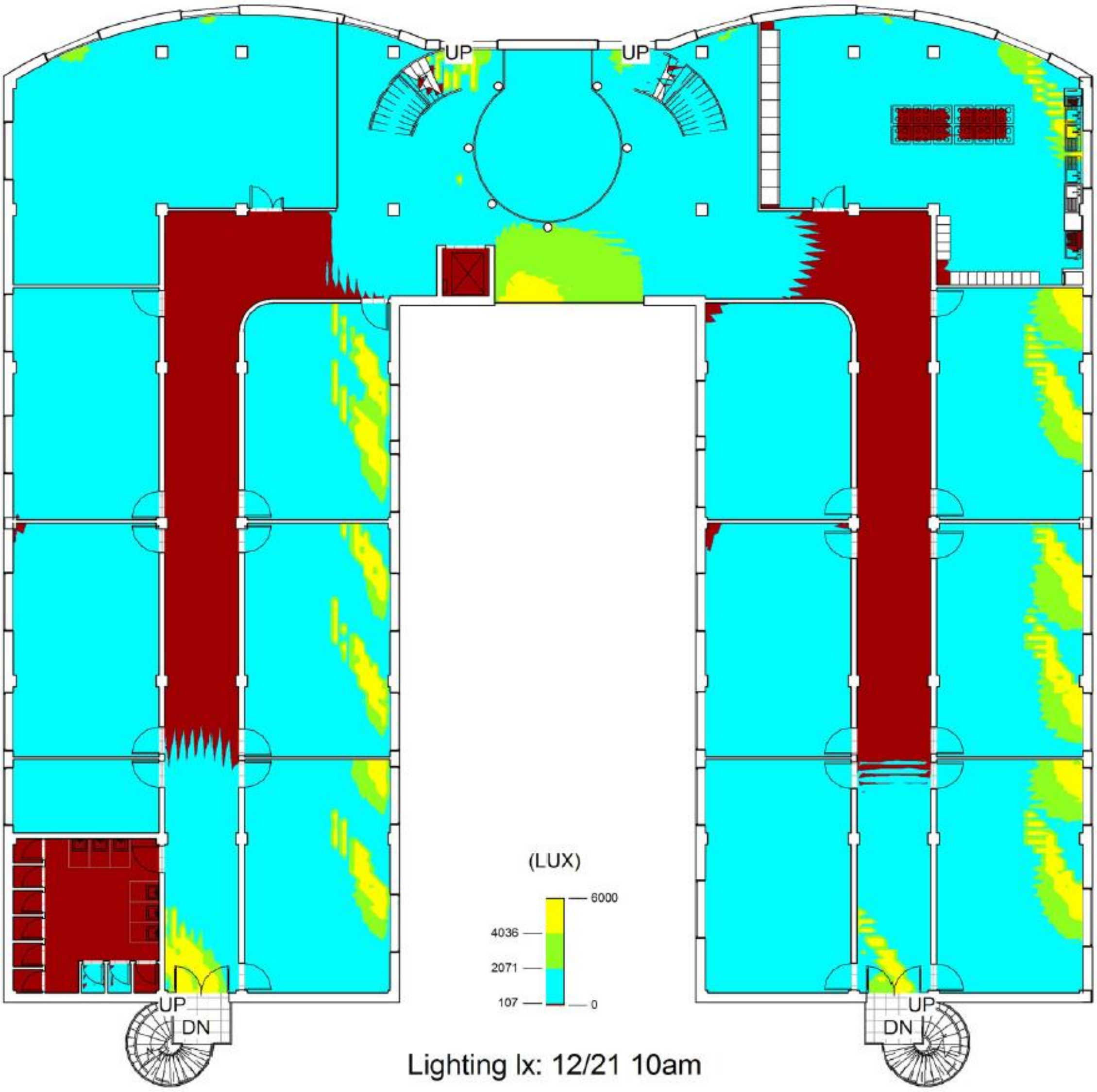


Figure 5.12. First floor daylighting at 10 am on 21st. December.

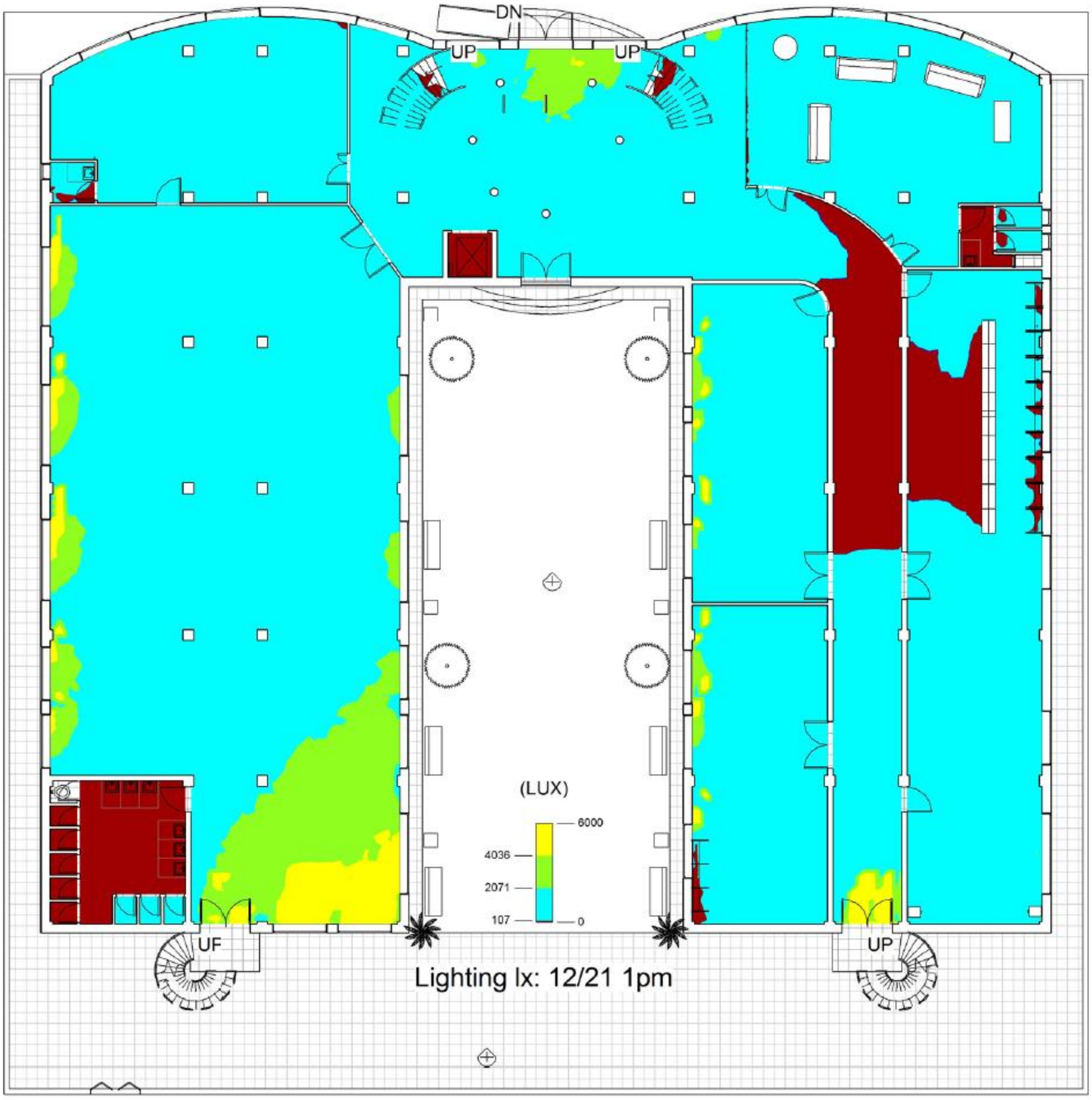


Figure 5.13. Ground daylighting at 1 pm on 21st. December.

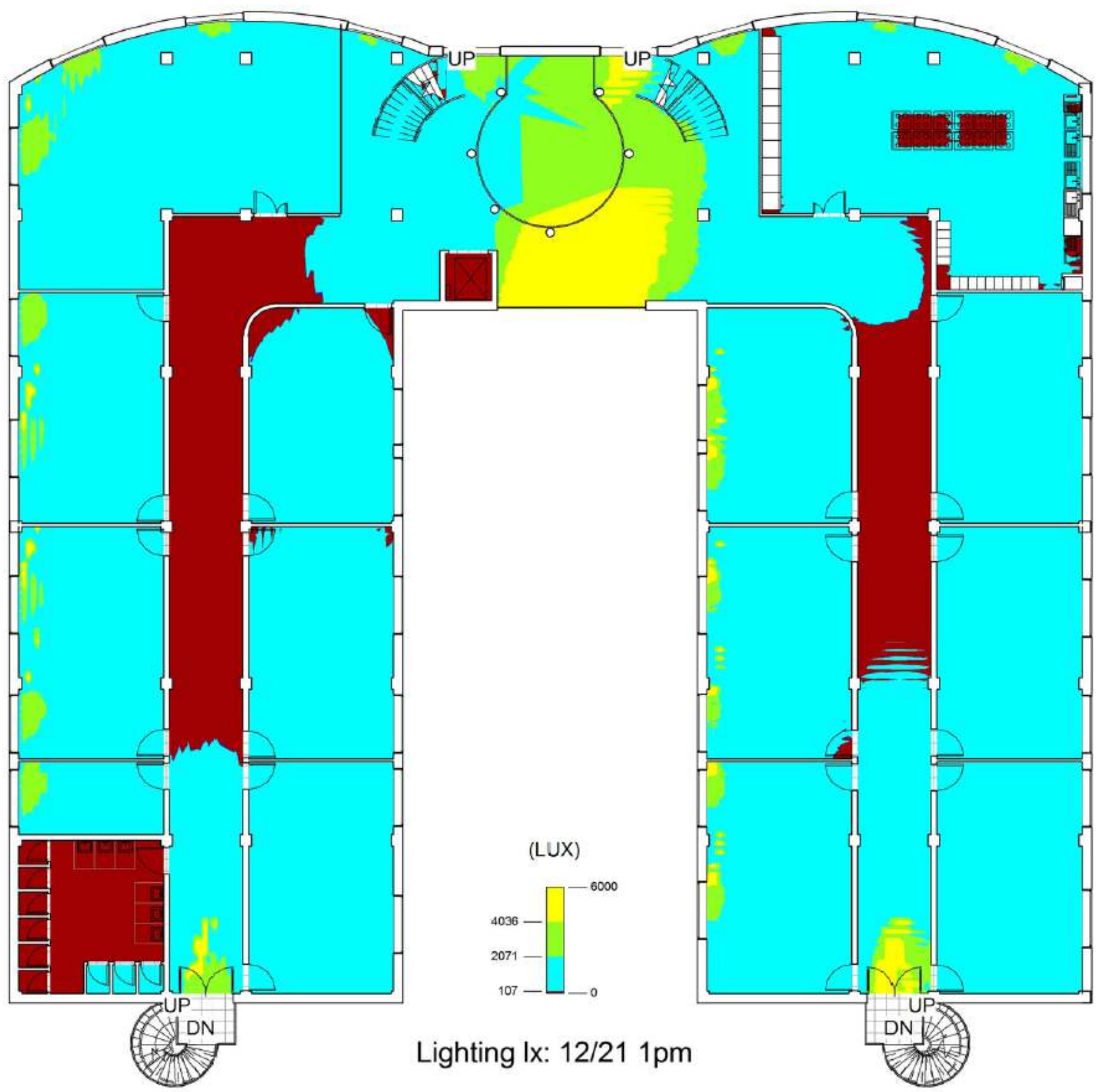
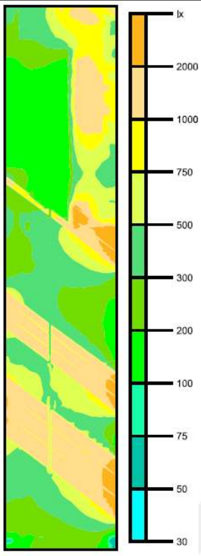
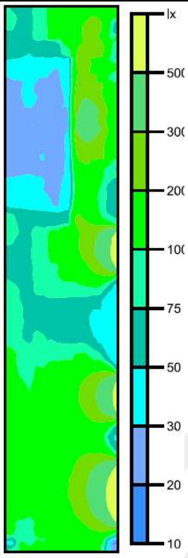
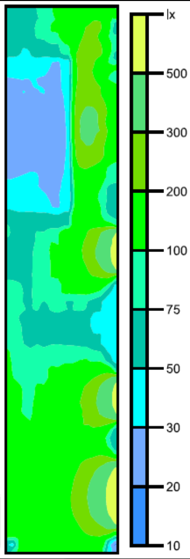
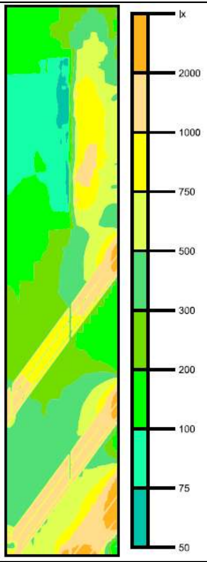
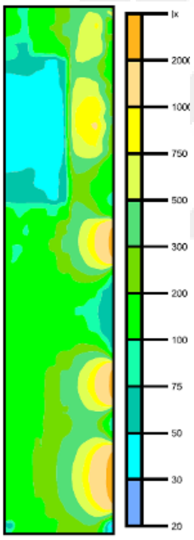
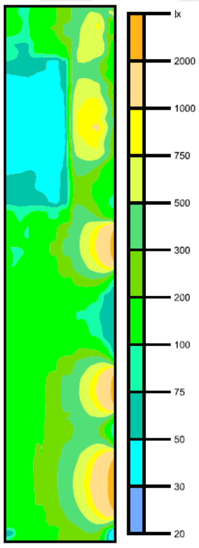
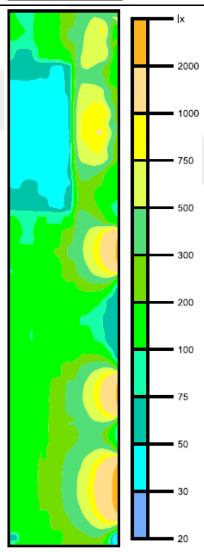
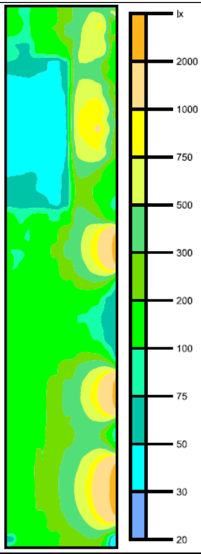
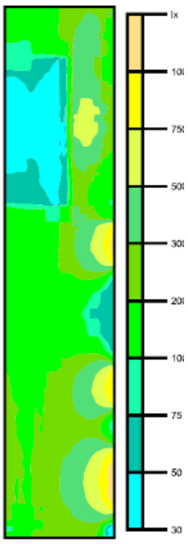
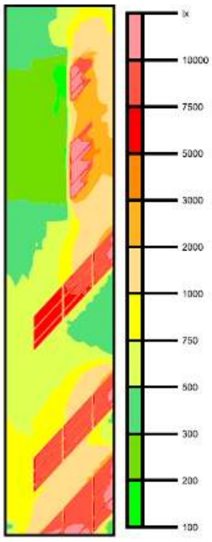
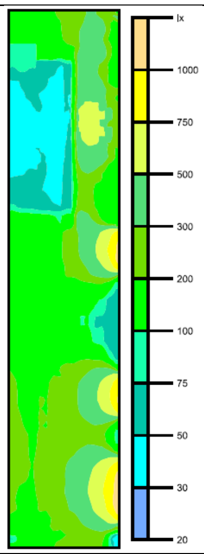
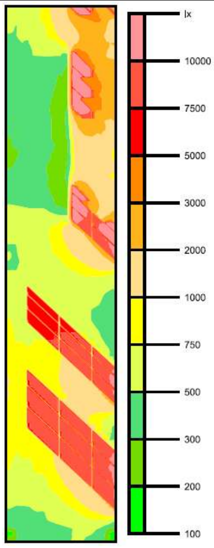


Figure 5.14. First floor daylighting at 1 pm on 21st. December.

5.5. The Energy Requirements of the Selected School Sample

Creating the simulation for spaces of school building model (SBM) at a height of (80) cm above the space of surface floor was done via Dialux Evo which getting the results as contour line waves. Every line had a certain amount of daylight. The results are as shown in Tables (5.2, 5.3, 5.4) for the Library at ground floor, Classrooms A and B at the first floor. The lines near the windows have a large amount of daylight and the amount of daylight waves is less step by step when the lines are far from the windows. The results of a simulation showing that can clearly be used to compare the number of spaces with (IES) standards.

Table 5.2. Daylighting level (LUX) as contour line waves for library look at the plan.

Library (21st DECEMBER)				
	North	South	East	West
08:00				
12:00				
15:00				

The color of illumination It is a measure of how much the incident light illuminates the surface, wavelength-weighted by the luminosity function to correlate with human brightness perception. the different colors of luminous emittance is the luminous flux per unit area emitted from a surface. The color shown in the library in a different direction, the waves of red and yellow contain a high level of illumination between (750 - 7500) lux, green color between (100 - 500) lux and blue between (20 - 100) lux. Furthermore, the waves near the windows have a high level of illumination and the illumination will decrease step by step when the waves are far from the windows.

Table 5.3. Daylighting level (LUX) as contour line waves for the classroom (A) at the first floor.

CLASSROOM A (21st DECEMBER)

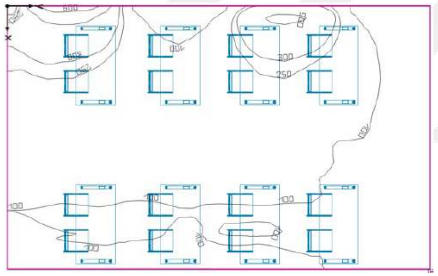
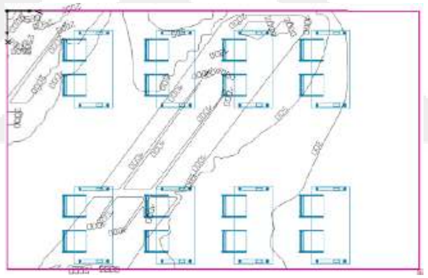
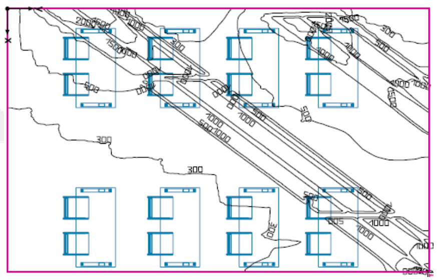
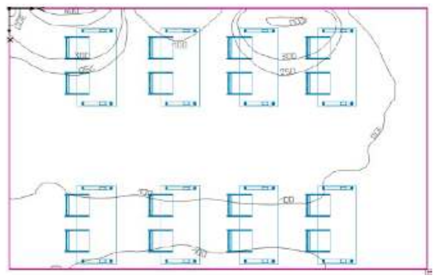
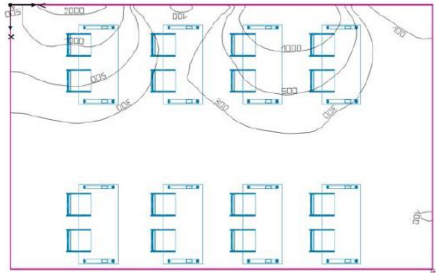
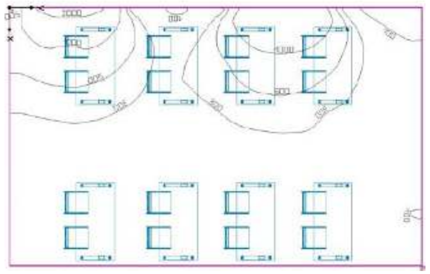
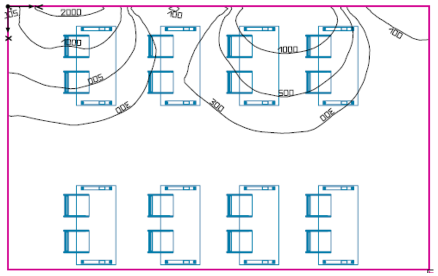
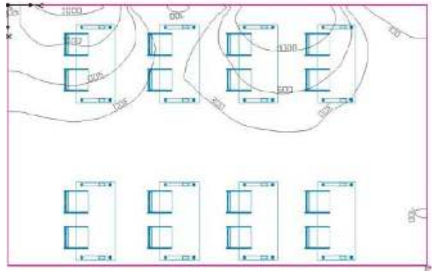
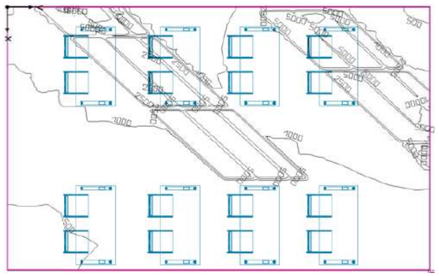
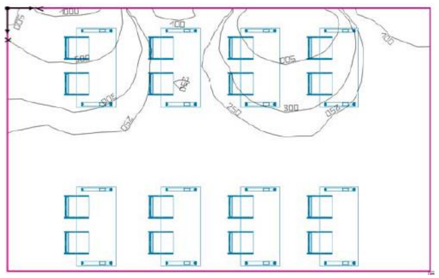
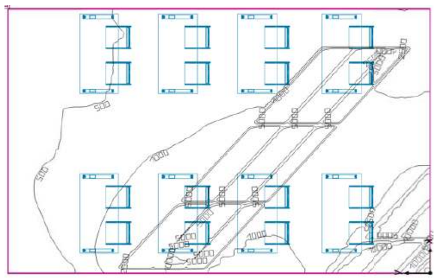
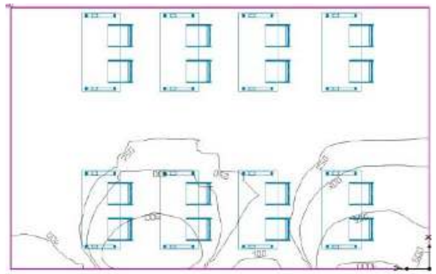
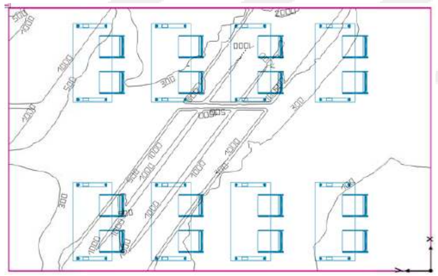
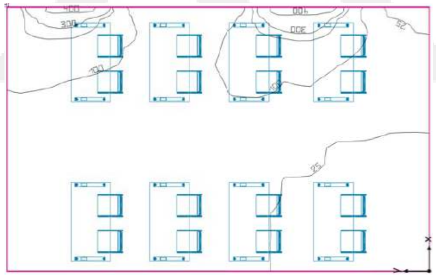
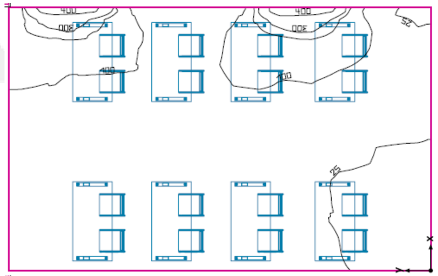
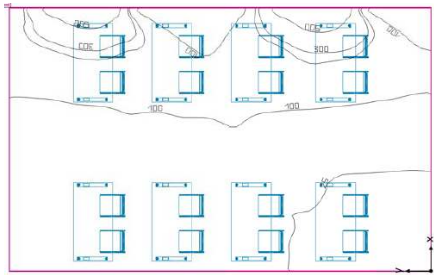
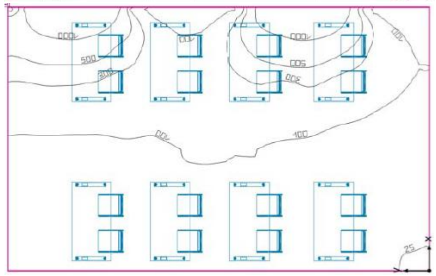
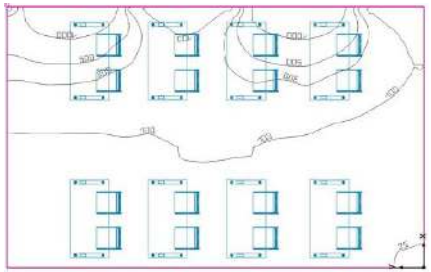
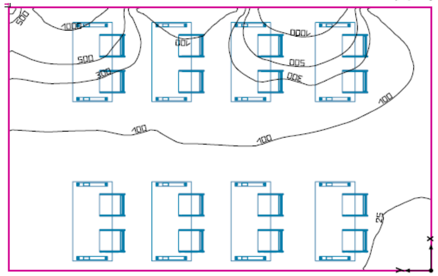
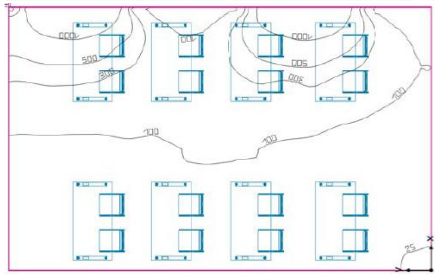
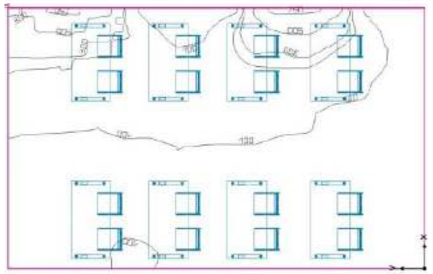
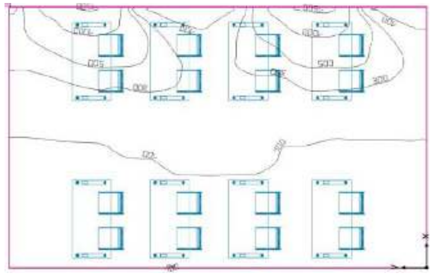
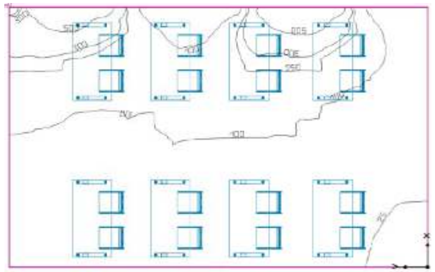
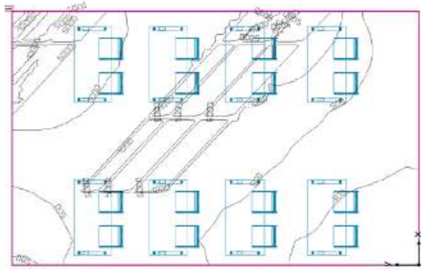
	North	South	East	st
08:00				
12:00				
15:00				

Table 5.4. Daylighting level (LUX) as contour line waves for the classroom (B) look at the plan (2) for the first floor.

CLASSROOM B (21st DECEMBER)

	North	South	East	st
08:00				
12:00				
15:00				

5.5.1.Windows area

The installation of windows on the SBM models in two different ways. First is by the floor ratio with a total area of windows of 532 m^2. The second is according to the wall ratio with the total area of the windows being 464 m^2, which was simulated for each. The windows according to the wall ratio have less of an area than the floor ratio of the building, therefore the energy consumption of heating and cooling in terms of the wall ratio is less than the energy consumption in the floor ratio. The artificial lighting according to the wall ratio is higher than the floor ratio, as in Figure 5.15. Advantages of windows area to wall and floor ratio

- ➢ The windows according to the floor ratio shows that there are more windows for the building, leading to the use of less artificial light and allowing more daylight to enter the building.
- ➢ The energy consumption of the windows according to the wall ratio means that there is less use of cooling and heating for the building during of year.

Disadvantages of the windows area compared to the wall and floor ratio

- ➢ Windows according to the wall ratio use more artificial light in the building.
- ➢ The energy consumption for windows according to floor ratio of the building uses a lot of cooling and heating during of year because the building contains a large area of windows.

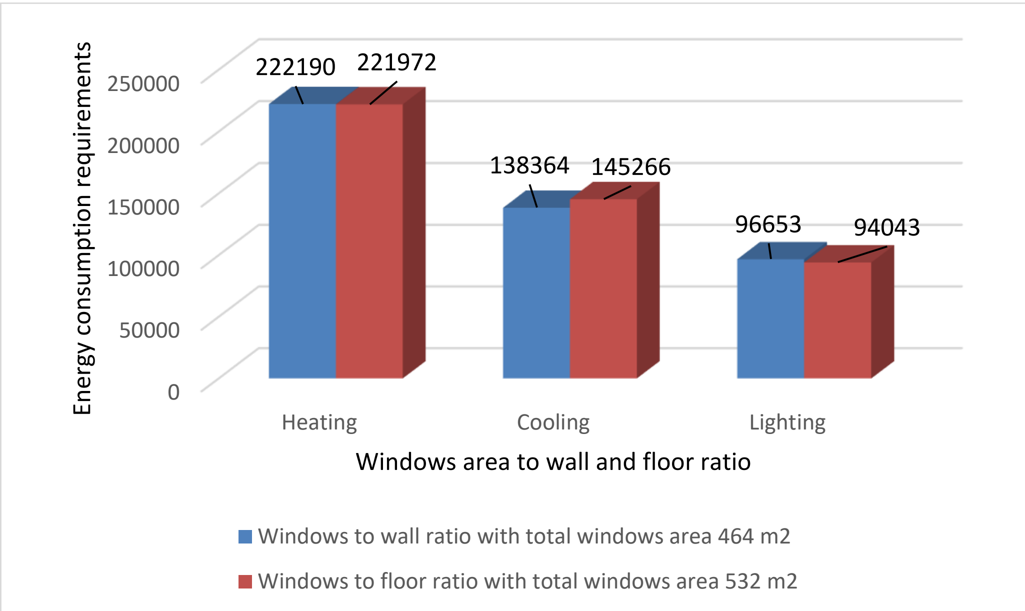


Figure 5.15. Results of heating, cooling and lighting for windows according to floor and wall ratio of the (SBM).

Windows and door windows are an important aspect of any building design. They are required for physical and visual connections but their interaction with heat gain/ loss and natural ventilation makes them and their design critical to a building's passive design. A window-to-floor ratio provides a rough approximation base for determining the optimum areas of the window in relation to the floor area of a room or building. As with all rules of thumb, it is used as a starting point for design and it can be confirmed through SBM modeling. This will help to understand the complexities of the thermal reactions in the building. The results in Figure (5.16) show the window area of (5–20) percent of the floor ratio for the use of heating and cooling in the building. The consequence of the results shown that, when increasing the ratio of SBM window led to reduced heating and increased cooling loads.

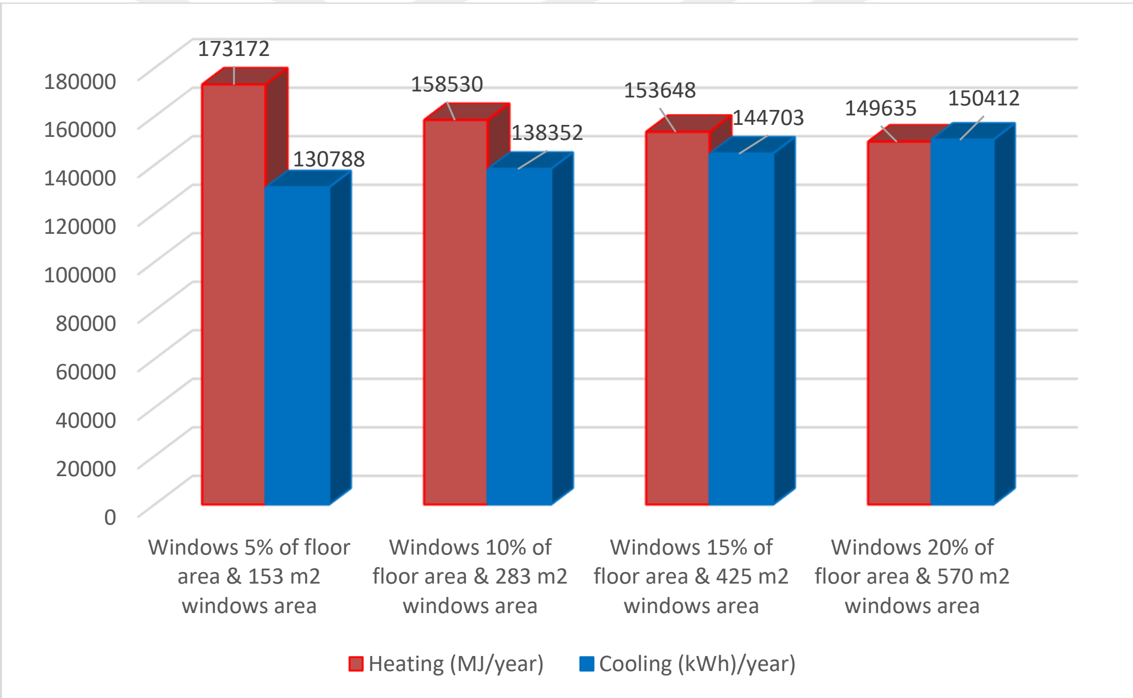


Figure 5.16. Result of five steps windows ratio to floor area.

5.5.2. Solar Photovoltaic Systems (PV)

Two methods of PV re created at the top of the SBM, first horizontally and then in the form of 0-degree panels. Second, there is the tilting pattern according to the optimal tilt of the city of Kirkuk, where the slope is 29 degrees. After locating the system, select panels and inverters and optimizing the tilting direction, created a simulation for both methods. A load of electricity consumption for the SBM model is 173 kWh, according to SBM model loads searched for the optimal connection of PV modules and the inverter that suits best. The annual PV energy yield of the horizontal panels is 223952 kWh and the tilted systems output is 259006 kWh as in Figure (5.17). The intensity of the current depends on the time of the sun's brightness and the intensity of the sun's rays. This is as well as the efficiency of the photovoltaic cell itself in terms of converting solar energy into electrical energy. The result indicates that the tilt of 29 ° according to Kirkuk location is better than 0◦ horizontal panels, but in summer at June and July the horizontal optimization is much better than the tilt as Iraqi houses use the maximum amount of electricity for cooling during the summer season. Therefore it will be better to adjust PV panels tilt angle according to different seasons (summer-winter) for harvesting higher energy during the year.

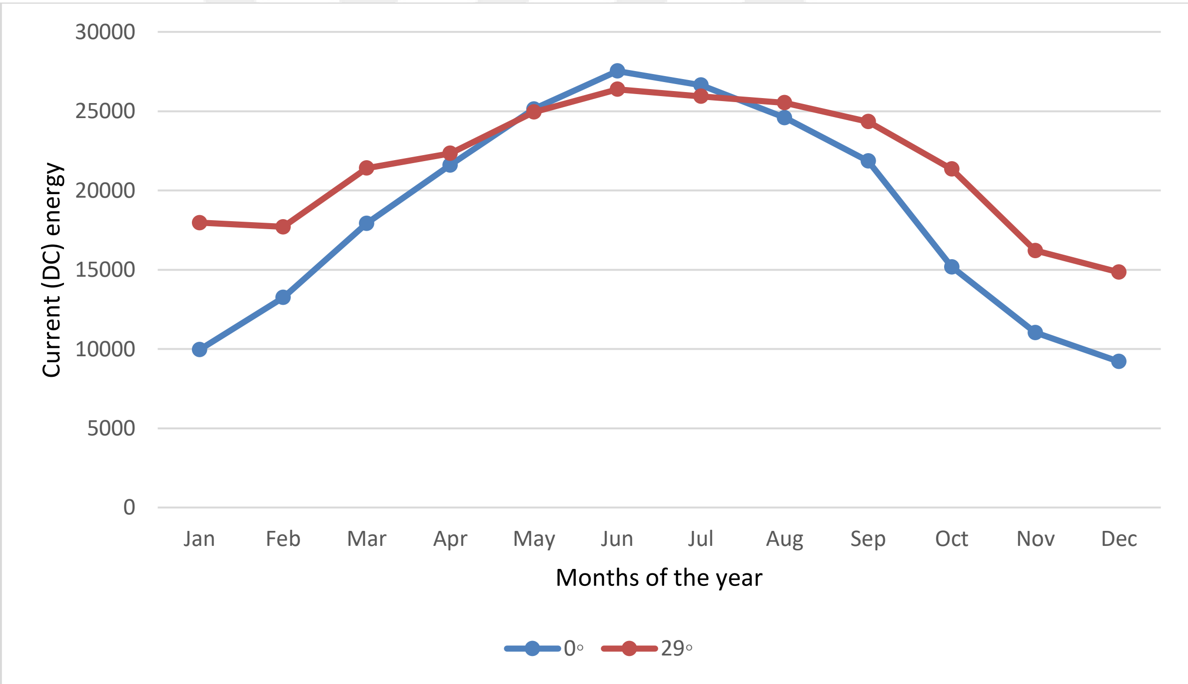


Figure 5.17. Monthly results of DC from PV panels for horizontal and tilted forms.

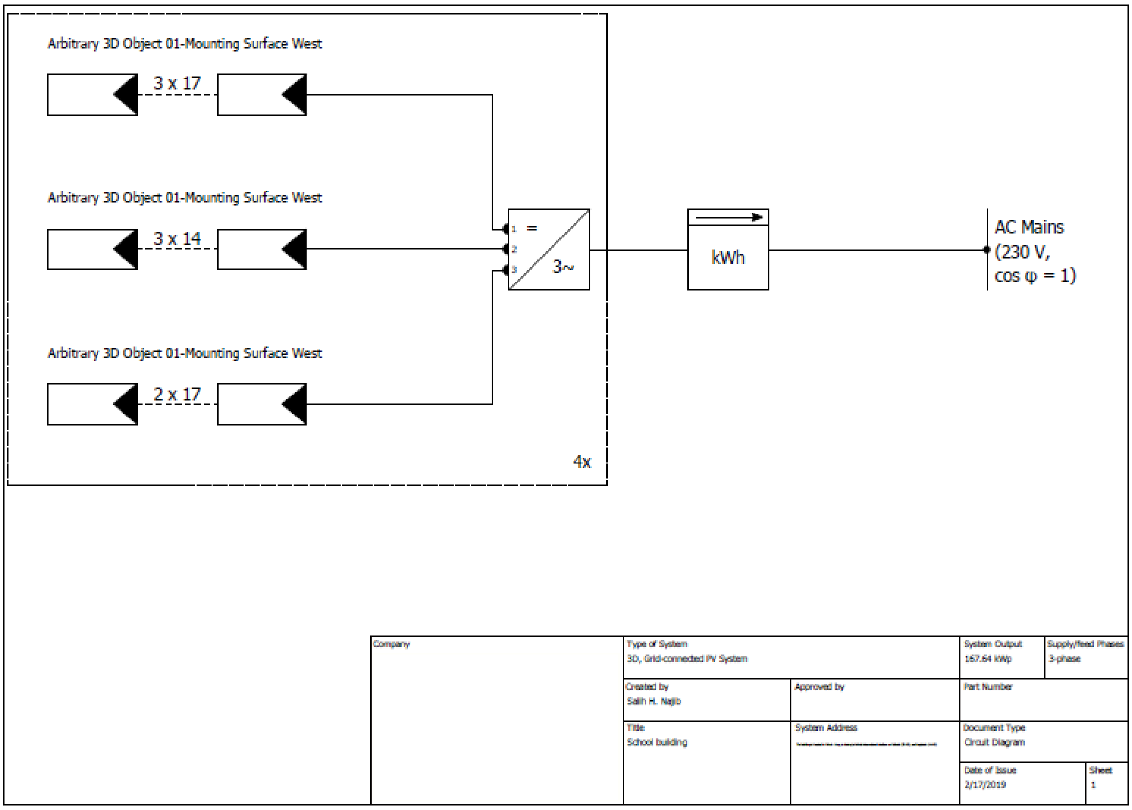


Figure 5.18. Panel and inverter connections of the system.

The three lines of panels are connected to the inverter, with each line indicating the number of panels in Figure (5.18). All panels (3 × 17 + 3 × 14 + 2 × 17) equal 127 which are connected to the inverter which converts the electricity from DC to AC. The SBM contains four types of this diagram which means that (127 x 4) equals to 508 panels located at the top of the roof which is connected to four inverters.

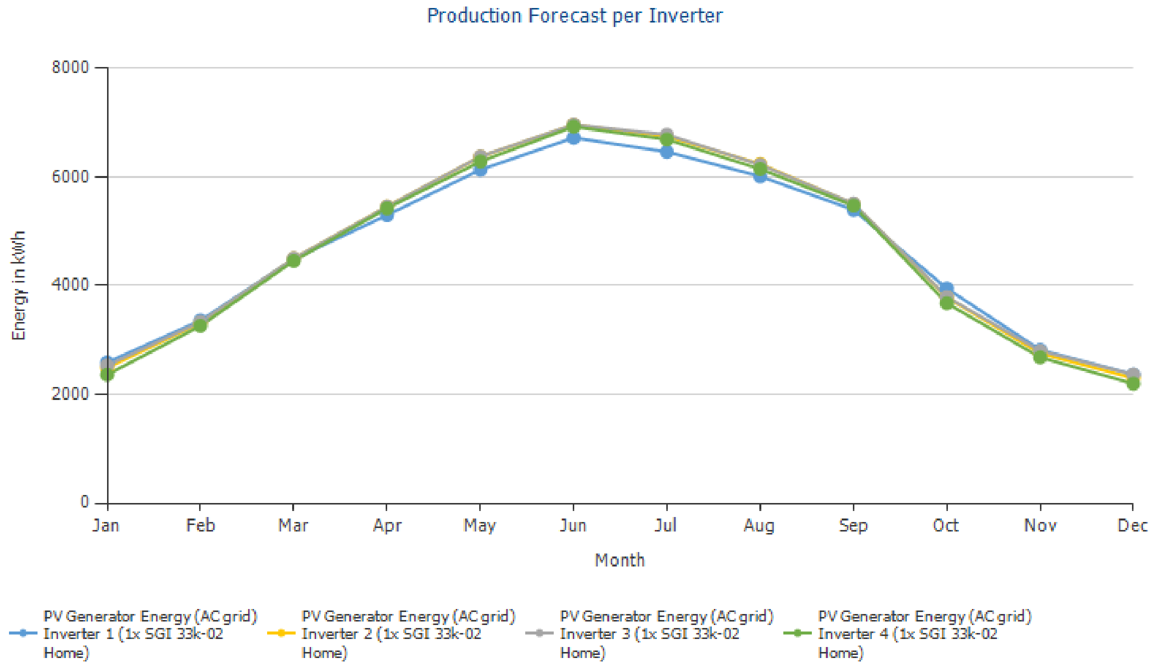


Figure 5.19. Four inverters convert electricity from DC to AC in kWh per month.

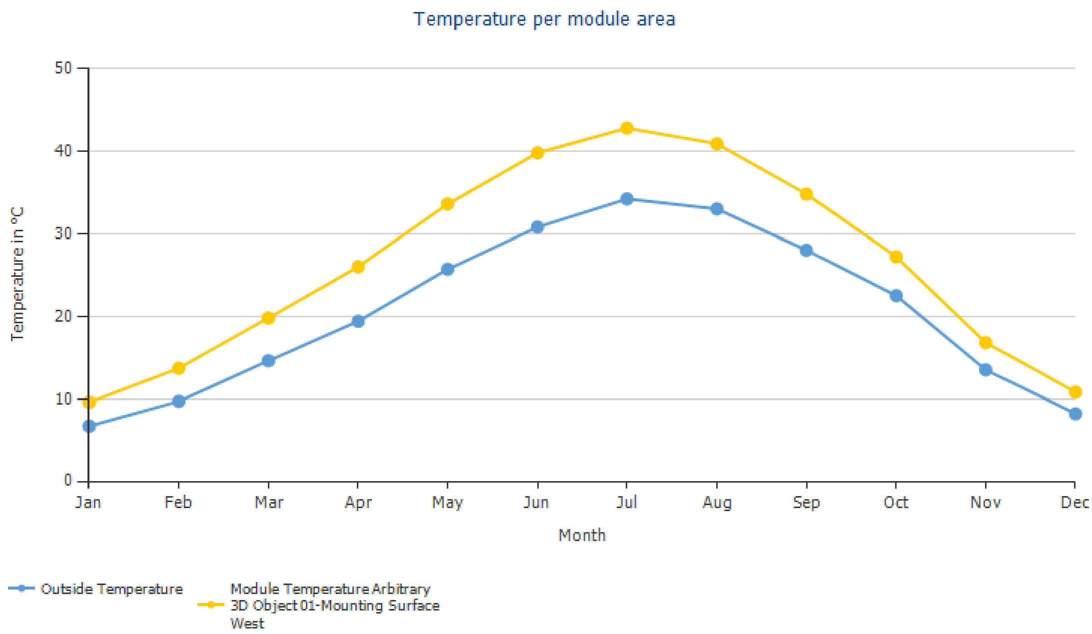


Figure 5.20. The external temperature and the panels module temperature.

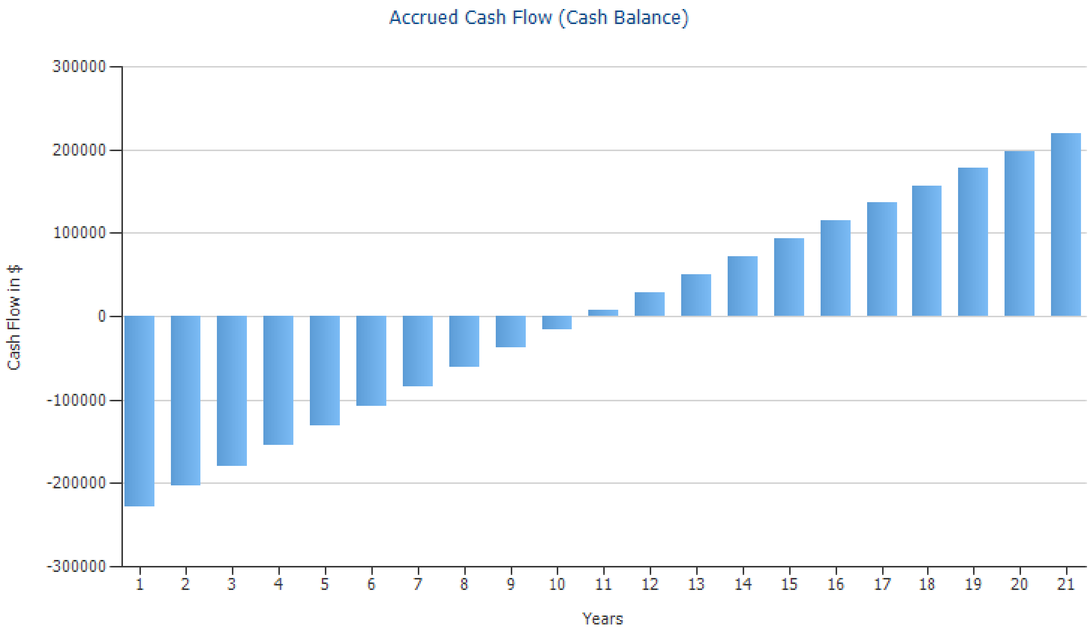


Figure 5.21. The payback period of the 0˚ horizontal photovoltaic panels.

Results of tilt 29◦ Panels

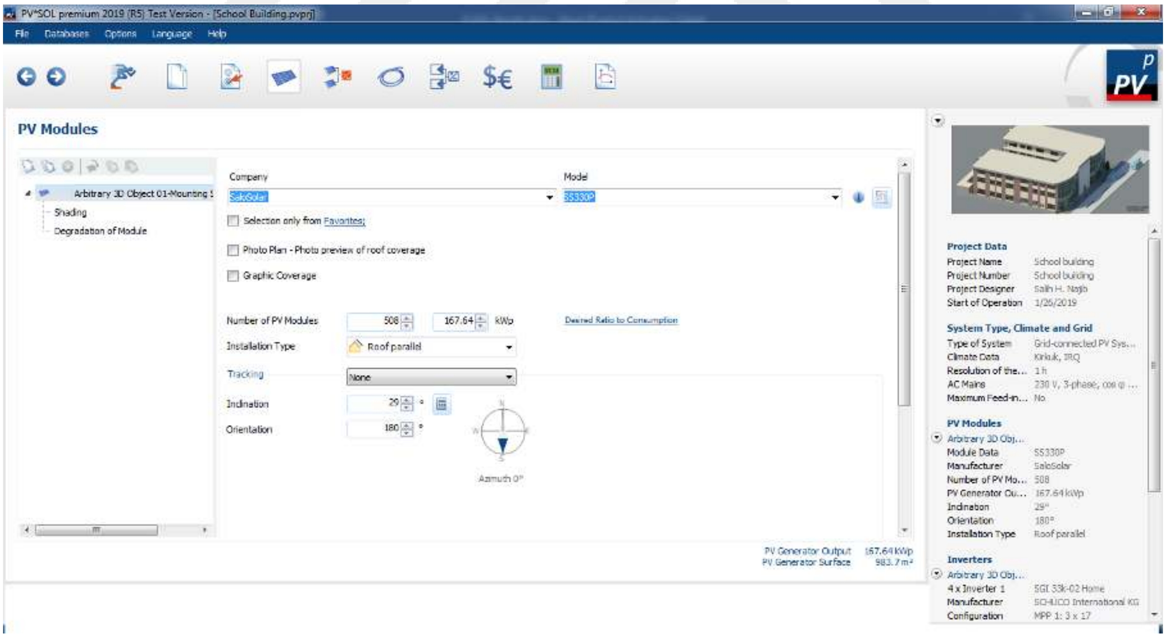


Figure 5.22. Tilt and orientation selection for Kirkuk city in PV*sol software.

PV System		
PV Generator Output	167.6	kWp
Spec. Annual Yield	1,545.01	kWh/kWp
Performance Ratio (PR)	76.1	%
Grid Feed-in	259,006	kWh/year
Grid Feed-in in the first year (incl. module degradation)	259,006	kWh/year
Standby Consumption (Inverter)	188	kWh/year
CO_2 Emissions avoided	155,403	kg / year

Arbitrary 3D Object 01-Mounting Surface West		
PV Generator Output	167.64	kWp
PV Generator Surface	983.7	m²
Global Radiation at the Module	2028.9	kWh/m²
PV Generator Energy (AC grid)	258996	kWh/year
Spec. Annual Yield	1545	kWh/kWp
Performance Ratio (PR)	76.1	%

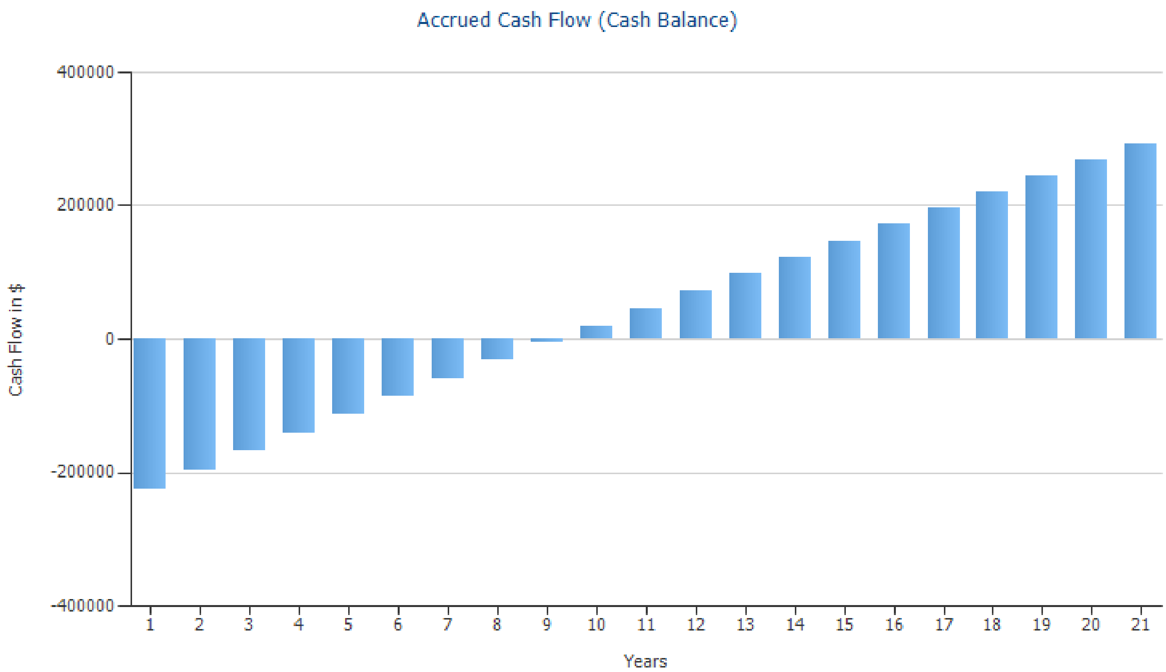


Figure 5.23. The payback period of the 29° tilted photovoltaic panels.

6. CONCLUSION AND RECOMMENDATIONS

The aim of this study is to describe how to reduce energy consumption and to improve indoor comfort conditions by using renewable energy sources in school buildings. Since buildings in Iraq are not built according to default standards and because the Iraqi standards for heat transfer (U-value) for the building elements are not updated, the bases and standards of Iraq will be evaluated to calculate for a suitable comfortable condition related to the performance of the internal climate of buildings and the use of these foundations. The purpose is to constitute a knowledge base on the importance of the use of insulation materials in school buildings, providing benefits for the immediate and future. This is because there is no habit or obligation to use isolation and a passive design strategy in the buildings in Kirkuk/Iraq.

This study is the first to provide empirical evidence of energy consumption in school buildings in Kirkuk, thus setting standards that designers, the government and operators can use in a similar climate. The study also analyzed the design of the school building using different thicknesses of thermal insulation. It thus identified some of the most important factors affecting the environment in the energy consumption in Kirkuk using the BIM (Revit) and PV*SOL programs and in the creation of simulations. Given that school buildings represent a large segment of the public buildings in Kirkuk, the results of this study can be used to construct building codes that set energy efficient standards for existing buildings in the same way as such codes exist for new buildings. U-shaped building plans provide a unique opportunity in designing both traditional and modern building plans. U-shaped building plans create a central courtyard that can be used as a large outdoor space for a wind circulation, natural light and landscape accessible from many points inside the building, which will increase natural ventilation and reduce industrial cooling. A key characteristic of SBM design as a good building design, such as those featured on base plans, is how the design incorporates natural light into the interior spaces throughout the day.

The benefits that can be achieved by employing passive and active design parameters for different cases related to the sample school building has been discussed and the optimum solutions that advertised

- Depending on the engineering programs that help to control thermal comfort in the interior space of the building and the early design stages to help make appropriate design decisions.
- Determine the climatic information for the area in which the building is located for use and employ it in a better design that meets the required quality and thermal requirements.
- The (SBM) building is an example of improving the efficiency of energy use in the building sectors and reducing the losses in exchange for the provision of energy or the regulation of its consumption.
- Determining the design means and procedures to be followed in order to construct an integrated building in form, content and performance, including the use of appropriate operating systems such as heating, air conditioning, lighting and ventilation systems.
- Know the nature of the building use and its function in order to determine its thermal load.
- Realize the characteristics of the structural materials and heat insulation intended to be used to reach the appropriate design that meets the requirements of residence and working within the space.
- After looking at the thermal performance of the school building model (SBM) in the Kirkuk city environment, it shows the relationship between the geometrical characteristics of the building with building energy - efficiency.
- In the area of school building laws that are currently in place, there are no determinants or controls related to the efficiency of the design of the school building from the health aspects in Kirkuk. SBM is an important sample to control the identification of healthy school buildings. This relies on local studies conducted for this purpose.
- The method used in the current study for the simulation of window areas is more comprehensive, taking into account the aspects dealing with solar radiation, ventilation and the good thermal performance of the building in order to measure the efficiency of the proportions of the windows.
- Conducting a study on the structural details related to the installation of solar panels through the PV*SOL program and the implementation of a simulation. It is also

looked at the relationship of solar panels with the local materials used for roofing to match the standard dimensions of the solar panels and the local materials.

- The study investigated a method for creating BIM-based 4D thermographic visualizations for the daylight performance analysis and lighting comfort evaluation of an existing building.
- Reduced heating and cooling costs through energy efficiency in the buildings and using materials that are enhanced to protect the comfortable interior climate.
- The use of thermal insulation to reduce the transfer of thermal loads inside and outside the building, using insulation materials for the building envelope and the materials commonly used in modern and most common buildings in Iraq is inclusive of the material Styrober (polystyrene).
- Good orientation can increase energy efficiency in the building, making it more comfortable to live in and cheaper in terms of the operating system for heating and cooling.
- The study and knowledge of the possibility of developing much of the self-design used in architecture in the field of cooling and heating in a passive way, in addition to the ability to control the external conditions, is in accordance with the requirements of the local climate to reduce energy consumption.
- The structural variables of the building play a role in influencing its thermal performance through the building envelope and this cannot be separated. This is what SBM should consider when dealing with the building elements.
- Based on the calculation comparisons presented in this study, it shows that Dialux Evo provides calculation results that of high accuracy and this can be compared with the standardized testing procedures.
- In this study, the simulation has been proven to be a powerful help for learning, problem-solving and design creation.
- The assessment of the internal conditions achieved the thermal satisfaction of the building occupants, in addition to the health and safety requirements.

Schools are high density occupational buildings, characterized by specific schedule occupations. In these cases, using the form and orientation creates insulation and uses the local climate for the location of the (SBM) building that can improve indoor comfort conditions that are necessary to guarantee an adequate learning environment. This is by using a passive heating and cooling system in order to remove any heat gained or to protect from external cold ather.

A simulation consists of an experiment done with a model. The general framework of a simulation has proven to be a powerful complement to learning, problem-solving and design in multiple fields. In this tutorial, it focuses mainly on the simulation of the heating and cooling system, the internal daylight, the photovoltaic power simulation (SBM) and the application of separate events. In the (SBM) building simulation, it seems that the north-oriented maneuvers are arranged with the southern windows that have the best performance. It brings more daylight into the courtyard area where the lighting levels are low, where the daylight distribution is balanced and where the glow is also greatly avoided.

An enabling and comfortable learning environment that meets the students' needs can help to promote active learning, thereby ultimately enhancing their conceptual understanding. It is therefore suggested that the systematic assessment of learning environments, especially the classroom’s thermal comfort, should be considered vital because the information obtained can be used as a basis for improving the quality and effectiveness of teaching in the classroom.

REFERENCES

[1] **W. Document,** 2008. “Design Guidelines for New Residential and Commercial Buildings,” no. May,.

[2] **M. Alwetaishi, A. Alzaed, G. Sonetti, R. Shrahily, and L. Jalil,** 2018. “Investigation of school building microclimate using advanced energy equipment: Case study,” *Environ. Eng. Res.*, vol. 23, no. 1, pp. 10–20,.

[3] BRE, “BRE Environmental & Sustainability Standard,” *BREEAM Court.*, no. 3, p. 368, 2009.

[4] **H. Herrmann and H. Bucksch,** 2014. *Building Regulations*, vol. 16, no. 452..

[5] **Y. Allab *et al.*,** 2017. “Energy and comfort assessment in educational building : Case study in a French university campus To cite this version : HAL Id : hal-01578585,”

[6] *- Ministry of Housing and Construction, Ministry of Planning, “Building Code of Iraq: Natural Ventilation and Health Assets Code”, (PO Box 505), First Edition, 2113. .*

[7] UNEP.IRD, “The National Environmental Strategy and Action Plan for Iraq,” 2013.

[8] **Hayder al-Khafaji,** 2018. “Electricity generation in Iraq Problems and solutions,”.

[9] “http://www.cosit.gov.iq/ar/2013-01-31-08-43-38.” .

[10] “http://www.dw.com/ar/في-العراق-البابليون-عرفوا-كيف-يبنون-بيوتهم/a-16159112.” .

[11] “http://www.moelc.gov.iq/index.php?name=Pages&op=page&pid=129.”

[12] **Nada Hadi Zaher,** 2007. “Water statistics in Iraq,”

[13] “Journal of Planned Issue and Development (34), Green Uses of Water in Iraqi Cities, Riyadh Kadhim Salman Al-Jumaily 2016.”

[14] I. Facilities, “Water Efficiency Manual Water Efficiency Manual,” 2009.

[15] U.S Department of Energy, “Building Energy Codes 101,” *U.S. Dep. Energy*, no. February, p. 37, 2010.

[16] **H. Altan, M. Hajibandeh, K. A. Tabet Aoul, and A. Deep,** 2016. “Passive design,” *Springer Tracts Civ. Eng.*, pp. 209–236,

[17] **W. Pan, H. Qin, and Y. Zhao,** 2017. “Resources , Conservation and Recycling Challenges for energy and carbon modeling of high-rise buildings : The case of public housing in Hong Kong,” *"Resources, Conserv. Recycl.*, vol. 123, pp. 208–218,

[18] **V. C. Sumanth, S. Rajkumar, and R. Venkateshwaran,** “Energy optimization by detailed analysis of analytical model A case study on Campus Building,” pp. 1–10.

[19] **A. Schlueter and F. Thesseling,** 2009. “Automation in Construction Building information model based energy / exergy performance assessment in early design stages,” *Autom. Constr.*, vol. 18, no. 2, pp. 153–163,

[20] **G. Kirankumar, S. Saboor, and T. P. A. Babu,** 2017. “ScienceDirect Thermal Analysis of Wall and Window Glass Materials for Cooling Load Reduction in Green Energy Building Design,” *Mater. Today Proc.*, vol. 4, no. 9, pp. 9514–9518,

[21] **S. Kota, J. S. Haberl, M. J. Clayton, and W. Yan,** 2014. “Building Information Modeling (BIM)-based daylighting simulation and analysis,” *Energy Build.*, vol. 81, pp. 391–403,

[22] **L. Díaz-Vilariño, S. Lagüela, J. Armesto, and P. Arias,** 2014. “Indoor daylight simulation performed on automatically generated as-built 3D models,” *Energy Build.*, vol. 68, no. PARTA, pp. 54–62,

[23] **J. B. Kim, W. Jeong, M. J. Clayton, J. S. Haberl, and W. Yan,** 2015. “Automation in Construction Developing a physical BIM library for building thermal energy simulation,” *Autom. Constr.*, vol. 50, pp. 16–28,

[24] **F. H. Abanda and L. Byers,** 2016. “An investigation of the impact of building orientation on energy consumption in a domestic building using emerging BIM (Building Information Modelling),” *Energy*, vol. 97, pp. 517–527,

[25] **N. Harmati and Z. Magyar,** 2015. “Influence of WWR, WG and glazing properties on the annual heating and cooling energy demand in buildings,” *Energy Procedia*, vol. 78, pp. 2458–2463,

[26] Guide and General Rules for Green Buildings, Ministry of Public Works - UAE, 01-290109-01, 29 January 2009. .

[27] **B. Sun *et al.*,** 2012. “Building Energy Management : Integrated Control of Active and Passive Heating , Cooling , Lighting , Shading , and Ventilation Systems,” pp. 1–15,

[28] **M. Ouf and M. H. Issa,** 2017. “Mohamed Ouf , PhD Candidate Mohamed Issa , Assistant Professor,” *Int. J. Sustain. Built Environ.*, no. May,

[29] **M. Molina-huelva, R. Chacartegui, and M. Molina-huelva,** 2017. “Accepted Manuscript,”

[30] **O. Bennani and I. Bensaadout,** 2016. “Positive Energy Office Building :,”

[31] **R. Sharma and L. Gidwani,** 2017. “Grid connected solar PV system design and

calculation by using PV SOL premium simulation tool for campus hostels of RTU Kota," *Proc. IEEE Int. Conf. Circuit, Power Comput. Technol. ICCPCT 2017*, pp. 1–5,

[32] **C. Holdermann, J. Kissel, and J. Beigel,** 2014. "Distributed photovoltaic generation in Brazil: An economic viability analysis of small-scale photovoltaic systems in the residential and commercial sectors," *Energy Policy*, vol. 67, pp. 612–617,

[33] **T. Patarau, D. Petreus, and R. Etz,** 2015. "Analysis and optimization of a geothermal, biomass, solar hybrid system: An application of PV∗Sol software," *Proc. Int. Spring Semin. Electron. Technol.*, vol. 2015-Septe, pp. 370–375,

[34] **S. Lou, E. K. W. Tsang, D. H. W. Li, E. W. M. Lee, and J. C. Lam,** 2017. "Towards zero energy school building designs in Hong Kong," *Energy Procedia*, vol. 105, pp. 182–187,

[35] *Standing Committee for the Preparation of the Egyptian Code of Energy Use, "The Egyptian Code for Improving Energy Efficiency in Buildings," Code No. 216/1, National Center for Building and Housing Research, Arab Republic of Egypt. !.* .

[36] "https://passiv.de/en/02_informations/02_passive-house-requirements/02_passive-house-requirements.htm." .

[37] *Syndicate of Engineers-Palestine, "Guide for Green Buildings-State of Palestine", Palestinian Higher Council for Green Building, 1st edition, 2013.* .

[38] *- Ministry of Housing and Construction, Ministry of Planning, "Building Code of Iraq: Natural Lighting Code", (PO Box 516), First Edition, 2113.* .

[39] T. L. Handbook, I. E. Society, and T. Lighting, "NCAT Interpretation of Current IES Illuminance Standards Engineering Society of North America Introduction : How to Use the Table," no. 406.

[40] "S. J. Jamil, 'THE ARCHITECTURAL AND CONSTRUCTING TREATMENTS FOR THE CLIMATIC AND ENVIRONMENTAL FACTORS,' vol. 35, no. 6, pp. 1575–1595, 2007."

[41] **M. De Castro and M. B. Gadi,** 2017. "EFFECT OF SLOPE ANGLE ON ENERGY PERFORMANCE OF GROUND-INTEGRATED BUILDINGS ON SLOPE TERRAIN," vol. 12, no. 2, pp. 283–293,

[42] **N. E. W. C. Ommercial and U. P. Ay,** 2011. "Use of the Building," vol. 10270, pp. 5–8,

[43] **D. Y. Goswami and S. M. Besarati,** 2013. "http://www.worldenergy.org/wp-

content/uploads/2013/10/WER_2013_8_Solar_revised.pdf,” *World Energy Counc. 2013 World Energy Resour. Sol.*, pp. 1–28,.

[44] **F. A. Ali,** 2011. “Computation of Solar Radiation on Horizontal Surface Over Some Iraqi Cities,” *Eng. Technol. J.*, vol. 29, no. 10, pp. 2026–2043.

[45] **N. E. R. C. A.-J.** (20-23\8\2007) Sura “Solar Radiation & Solar Radiation Measurements”, 4 days training course, Photovoltaics Division, “No Title.”

[46] *- Ministry of Housing and Construction, Ministry of Planning, “Building Code of Iraq: Central Heating Code”, (PO Box 4/414), First Edition, 2113.* .

[47] American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE), “ANSI/ASHRAE Standard 140-2001: Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs.,” *Ashrae*, vol. 140–2001, p. 77, 2014.

[48] **D. Witzel,** 2012. “DIALux Evo – new calculation method,” vol. 059, pp. 1–16.

[49] **V. Geletka,** “Vladimír Geletka, Anna Sedláková *1 Shape of Buildings and Energy Consumption Kształt Budynków a Zużycie Energii.”

[50] U. Department of Energy, “AN ASSESSMENT OF ENERGY TECHNOLOGIES AND RESEARCH OPPORTUNITIES Issues and RDD&D Opportunities,” no. September, 2015.

[51] “Syrian Arab Code Fourth Edition 2012. الكود العربي السورية الطبعة الرابعة 2012.” .

[52] *Ministry of Housing and Construction, Ministry of Planning, “Building Code of Iraq: Thermal Insulation Code”, (PO Box 501), First Edition, 2013.*, (م.ب.ع 501. 2013.

[53] **K. F. Çetintaş and Z. Yilmaz,** 2017. “Optimization of thermal insulation material and thickness for building energy efficiency in Mediterranean climates based on life cycle perspective,” *A/Z ITU J. Fac. Archit.*, vol. 14, no. 3, pp. 99–112,.

CURRICULUM VITAE

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- **<u>Work Experience:</u>**

September 2017 – September 2019 Firat University in Elazig/ Turkey

At the during of my education for the master, I studied about:

- Passive design strategies and active systems.
- U-values of building materials and Building Information Modeling (BIM).
- Heating and cooling energy consumption working with Heating, Ventilating, and Air Conditioning (HVAC) system and creating simulation by Revit program also using American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard in building performance analysis green building studio.
- Make project-creating simulation of construction site working and cost estimation with worker and construction time plan by using Navisworks program.
- Installing solar panels for single-family house model and creating simulation by Pvsol and Pvsys program.

March 2016 – July 2017 Karwanchi Co. (Soft drinks & Healthy water)

I worked as a supervising engineer for a few projects in (Prdey /Kirkuk) as the following:

- Design and implement rainwater and wastewater pipes (serage system) for the project.
- Design and implement network water system.
- Supervising and implementing digging test.
- Design and implement some latrine for company labors.
- Working as a supervisor engineer for constructing a warehouse.
- Working as a supervisor engineer to implement a hotel building with three floors.
- Working as a supervisor engineer to implement concrete for a parking area and ramps with a retaining wall.

September 2015 – May 2016 Vitosha Co. (General contract & Trading)

I worked as site engineer for the project of (Khabat thermal power plant unite 1, 2 Erbil /Kurdistan) my duty was like the following:

- Working for the finish of the buildings.
- Working with a few buildings using for a power station.

In addition, a description of the efficiency of the work.

March 2015 – September 2015 REACH (LNGO) organization

I worked as Monitor Engineer for the projects WASH Project / WASH intervention (Water, Sanitation and Hygiene), EFSVL (Emergency food security vulnerable livelihood) and (re-integration, advocacy, and building capacity). This project implementing by REACH with Partner OXFAM GB.

- Support and supervise the planning, organizing and implementing all activities.
- Project scheduling and resource management.
- Preparing plan project process and work-plan for the project process and follow up
- Monitoring, and reporting on projects.
- Make presentations on project status, present weweekly and monthly reports to senior management.
- Conduct performance reviews of team members and identify areas of improvement, give feedback and recommend for promotions.
- Checking and Preparing BoQ (Bill of Quantity) and Estimate project budgets and monitoring.
- Preparing contract documents and taking into consideration of Org.'s polices, Mandate and general standards and specifications.
- Time Estimating, Cost Estimating, Developing a Budget and procurement documents.

January 2014 March 2015 Shiwasor Co. For (General & Contracting)

I am working as a Site Engineer for the project of (Construction, Equipping, and furnishing of Dental center in Raheem-Awa/Kirkuk) my duty as the following:

- Installation rainwater and wastewater pipes for 100 lengths from the building to the main street.
- Redesign the Building.
- Erection the columns by Total station instrument.
- Gave attention to the building craftsman.
- Concentrate on completion or finishing of the building in during of the work.
- Dealing with authority through the project requirements, group discussion, and role-playing about how to accept the authority of the company conditions and idea on the project, a description of the efficiency of the work.

November 2013 – January 2014 Shiwasor Co. For (General & Contracting)

I worked as Site Engineer for the project of (Design and implementation of the ser line of rainwater in the green neighborhood/Kirkuk) my duty was like the following:

- Give advice for surveyors and team leaders.
- Implement GRP pipe with diameters (1000, 1100, and 1200) mm for Main Streets.
- Implement Upvc pipe with diameters (1000, 1100, and 1200) mm for branch streets.
- Excavations for pipeline trenches and take care of all safety provisions using site rails and try to be carried out in stable slope for which is not little or extra excavate.
- After transporting the pipe to worksite and unloading try loring in trench, laying & jointing pipe by an excavator.
- Cover the pipe by layer granular bedding Class B not more than 30 cm with good compaction.
- Constructing Junction Manhole with diameters (1.2, 1.5) m.

November 2011 – November 2013 AVA Spor (Construction & General trading)

I am working as Surveyor and Construction Architect at the project of Kirkuk Olympic stadium and my duty as a following:

- Participate for design pipes and manholes also calculate water flows and dimension of pipes according to standards.
- New buildings.
- Renovation the stadium.
- Olympic football yard by FIFA standard.
- Designing.
- Surveying.
- Organizing teamwork on the site.
- Dealing with Consultancy Company.

September 2010 – October 2011 Palkana Company (For general Trading & Constriction)

I am working as a Surveyor and Construction Architect my duty as a following:

- Implement network water supply from a large reservoir in Hesabat to Hay Askary and Kurnish crossing the Hassa in Kirkuk.
- Working by instruments Total station, Theodolite, Level
- Redesign the project especially building
- Designing
- Organizing teamwork on the site
- Dealing with authority
- Tender documentation and general project.

May 2010 – August 2010 AVA Spor (Construction & General trading)

I was working as a project manager in a stadium project for (basketball, volleyball, and handball) in Reano primary school in Sulaymaniyah my duty was like the following:

- AutoCAD program
- Key junction
- Detailed drawings of elements
- Designing
- Organizing teamwork on the site
- Dealing with contractor and subcontractor
- Dealing with authority

February 2010 – May 2010 Palkana Company (For general Trading & Constriction)

I was working as a project manager from 1st February 2010 to 12th May my duty as a following:

- Organizing teamwork on the site
- Developing the budgets
- Dealing with authority
- Tender documentation and general project.

April 2008 – July 2008 Internship at 3XN (Architect firm in Copenhagen)

I was an intern for 10 eks a 3XN A/S – an architect firm in Copenhagen. I worked with a huge project at The Bella Centre. The project consists of building two hotel tors in close proximity of each other. Each tor has 23 floors and 400 rooms. The project will cost more than one billion DKr.

At 3XN I worked with a variety of projects:

- AutoCAD program
- Key junction
- Detailed drawings of elements
- Fire plans
- Different kinds of meetings (individual meetings with employers, group meetings, company meetings, and meetings with engineering and installation firms).
- Printout documentation and drawings for preparation of proposals.

March 2006 – January 2008 Danish Red Cross

I worked with building section for asylum seeker and duty was as the following:

- Support the team by undertaking drawing in the AutoCAD program.
- I included the production of sketches.
- Assist in the development of budgets.
- Prepare local authority and tender documentation and general project organization.

July 1999 – October 1999 Internship at an Agricultural Office in Iraq

I interned for three months at an agricultural administration office in Iraq. I worked with the following for three months:

- Visited agriculture areas and sites for field farming.
- Used topographical maps and agricultural maps, worked for boundaries agricultural lands to a number of farmers.
- Used surveyor instruments like table plans and tapes to divide the agricultural areas between the farmers.

• **Education and Qualifications:**

Date	Education	Place
2017- 2019	Architecture Firat Unversity	Elazig/ Turkey
2005 – 2009	Construction Architect Copenhagen Technical Academy	Copenhagen/Denmark
1997 – 1999	Technical Institute: Surveying	Suleimania / Iraq
1990 – 1996	High school Diploma	Kirkuk / Iraq
1984 – 1990	Primary school	Kirkuk / Iraq

Date	Courses	Place
06.11.2010 – 13.11.2010	Total Station Instrument	Sulaimany/Kurdistan Region
16.04.2007–18.06.2007	New head way intermediate	Studieskolen/Copenhagen
05.02.2007 – 26.03.2007	New head way intermediate	Studieskolen/Copenhagen
1.08.2005	Reception and Administratio	Culture house/Copenhagen
17.01.2005 - 29.06.2005	Skills4life	Culture house/Copenhagen
15.11.2004 - 29.06.2005	PC license “kørekort”	Culture house/Copenhagen

- **Language Skills:**

Languages	Spoken	Written
Kurdish	Fluent	Fluent
Arabic	Fluent	Fluent
English	Fluent	Good
Danish	Good	Good
Farsi	Good	Fluent
Turkish	Basic	Basic

- **Computer Programs:**

I am a skilled PC user and have good experience with MS Office, MS Office project, AutoCAD, Revit, Revit simulation, Green Building Studio, Design Builder, Navisworks Manage, Sketch-up, Photoshop, Build Disk and Sigma.

- **Driver license:**

I have an Iraqi driver's license for general cars driving.

- **Voluntary Work:**

March 2006 – March 2008 Red Cross in Denmark

I worked voluntarily at the Danish Red Cross. I worked in many areas:

- AutoCAD program
- Renovated buildings
- Furniture plans
- Fire plans
- Meetings
- Material catalogs
- Prices
- Arranged folders and worked with documentation in their archives.